# (EEAP) BOILER AND CHILLER STUDY II

AT

# FORT SAM HOUSTON

SAN ANTONIO, TEXAS

**VOLUME I**

PRE-FINAL REPORT

**US ARMY CORPS OF ENGINEERS**
Fort Worth Division



CONDUCTED BY:

***HUITT ZOLLARS, INC.***

CONSULTING ENGINEERS
FORT WORTH, TEXAS

**10/31/96**

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## ABBREVIATIONS

| | |
|---|---|
| A | Amperes |
| ACR | Air Cooled Reciprocating |
| AHU | Air Handling Unit |
| ASHRAE | American Society of Heating, Refrigeration & Air Conditioning Engineers |
| BTU | British Thermal Unit |
| BTUH | British Thermal Unit per Hour |
| CFM | Cubic Feet Per Minute |
| CHW | Chilled Water |
| CMU | Concrete Masonry Unit |
| CW | Condenser Water |
| COE | U.S. Army Corps of Engineers |
| CPS | City Public Service |
| DB | Dry Bulb Temperature |
| DCW | Domestic Cold Water |
| DDC | Direct Digital Control |
| DHW | Domestic Hot Water |
| DPW | Directorate of Public Works |
| DX | Direct Expansion |
| ECI | Energy Cost Index |
| ECO | Energy Conservation Opportunity |
| EER | Energy Efficiency Ratio, BTUs per Watt-Hr |
| EMS | Energy Management System |
| EUI | Energy Usage Index |
| °F | Degrees Fahrenheit |
| FCU | Fan Coil Unit |
| FSH | Fort Sam Houston |
| FT, ft | Feet |
| GPM, gpm | Gallons per Minute |
| HP | Horsepower |
| HRS, hrs | hours |
| HPS | High Pressure Steam |
| HTG | Heating |
| HVAC | Heating, Ventilating & Air Conditioning |
| HW | Heating Water |
| HZ | Huitt-Zollars, Inc. |
| IAQ | Indoor Air Quality |
| KGAL, kgal | Kilogallon |
| KW | Kilowatt |
| KWH | Kilowatt Hours |
| LCCID | Life Cycle Cost In Design |
| LPS | Low Pressure Steam |
| MBH | 1,000 BTUH |
| MBTU | 1,000 BTUs |
| MMBTU | 1,000,000 BTUs |
| MCF | 1,000 Cubic Feet (gas) |
| MH | Metal Halide |
| MISC, misc | Miscellaneous |
| M&O | Maintenance & Operations |
| MWH | Megawatt Hours |
| N/A | Not Available or Not Applicable |
| OA | Outside Air |

| | |
|---|---|
| RTU | Rooftop Unit |
| SZ | Single Zone |
| SQFT, sqft | Square Feet |
| TON, ton | 12,000 BTUH |
| UPH | Unlisted Personnel Housing |
| USAED | U.S. Army Engineer District |
| V | Volts |
| VAV | Variable Air Volume |
| VFD | Variable Frequency Drive |
| W | Watt |
| WB | Wet Bulb Temperature |
| YR, yr | Year |

# (EEAP) Boiler/Chiller Study II

at

# Fort Sam Houston

San Antonio, Texas

## I. EXECUTIVE SUMMARY

A. Introduction

This energy conservation study was performed by Huitt-Zollars Inc, for the U.S. Army Engineer District (USAED), Fort Worth, under contract number DACAC63-94-D-0015. The study was conducted at Fort Sam Houston (FSH) in San Antonio, Texas, between September 28, 1995 and May 31, 1996. The site survey, data collection and analysis was performed by John Carter, E.I.T, Chris Pieper, P.E., and M. A. Shafiq, P.E.

The purpose of the study was to perform a limited site survey of specific buildings at the facility, identify specific Energy Conservation Opportunities (ECOs) that exist, and then evaluate these ECOs for technical and economic feasibility. These ECOs were limited to central boiler and chiller plant systems serving specific building groups at FSH.

This study is the second phase of a Boiler/Chiller study completed by Huitt-Zollars, Inc. for The Corp of Engineers on September 18, 1995. In addition to the work that was accomplished in that project, additional buildings for three of the areas analyzed previously andtwo new areas have been added to the Scope of Work for this phase. Therefore, much of the same data that was gathered for the first phase will again be used in this second phase to identify ECO's.

This survey was conducted with the assistance of many individuals at FSH. Special thanks are extended to all of them, including the following individuals:

David Brigham, Cultural Resources
Mike Brynes, Operations and Maintenance
Frank Carbonell, Engineering Services
Bill Coates, Operations and Maintenance
Guy Cox, Operations and Maintenance
Al Motz, Operations and Maintenance
Gene Rodriguez, Engineering Services

Other individuals who assisted in this study by providing equipment and cost data are listed as follows:

Tom McGreal and John Wright, York International, Dallas, TX
John Neal, Jr. and Gary Caffey, Neal and Associates, Dallas, TX
Joe Scolaro and Brian Mitchell, Mitchell Technical Sales, Dallas, TX
Preston Dickson, Timberlake and Woffard, Inc., Dallas, TX
Larry Carpenter, The Trane Company, Fort Worth, TX
David Recca, DynaService, Fort Worth, TX
Bob Stevens, City Public Service, San Antonio, TX

Any questions concerning this report should be directed to the ProjectManager, Michael W. Elliott, P.E., CEM, at Huitt-Zollars Inc., 512 Main Street, Suite 1500, Fort Worth, Texas 76102. Phone 817-335-3000, extension 270.

B. Buildings Studied

This study was performed on five separate groups of buildings at the Fort Sam Houston installation in San Antonio, Texas. These groups were identified as Areas 100, 500, 1000, 1300, and 2200. Buildings in each of these areas are briefly described as follows:

Area 100: Thirty-eight buildings currently used as office buildings, barracks, and other miscellaneous usage.

Area 500: Buildings in this area consisted of three Unaccompanied Personnel Housing (UPH) barracks.

Area 1000: Buildings in this area consisted of two office buildings and the Brooke Army Medical Center.

Area 1300: Buildings in this area consisted of seven barracks, a dining hall, a theater, a chapel, a mini-mall and an Administrative office building.

Area 2200: Buildings in this area consisted of three barracks, a chapel, a theater, the military police station, and six Administrative office buildings.

C. Present Energy Consumption

*Base Year Energy Consumption:* The total metered electrical and gas consumption data for twelve consecutive months prior to the study were obtained from the facility and are referred to as "base year". This "base year" data represents the consumption for the entire installation, as well as the buildings in this study. Refer to Figure 1 for a summary of the monthly energy usage data shown on Page 18.

**Figure 1. Base Year Energy Usage By Source**

| ENERGY SOURCE | ANNUAL USAGE | | COST $ |
|---|---|---|---|
| Electricity | 153,580 MWH | 524,169 MMBTU | 6,567,101 |
| Natural Gas | 405,282 MCF | 405,282 MMBTU | 1,690,065 |
| Total | | 929,451 MMBTU | 8,257,166 |

The annual energy consumption for the boiler and chiller systems studied was calculated in Appendix H, using the Trane Trace 600 computer program to model buildings and existing HVAC systems. This consumption amounted to a total of 7.9% of the base energy usage and 7.5% of the energy costs. Refer to Figure 2 for a summary of the boiler and chiller systems energy consumption and demand data.

**Figure 2. Annual Boiler and Chiller Energy Consumption Data**

| AREA | COOLING SYSTEM DEMAND $/YR | COOLING SYSTEM ELECT. KWH/YR | COOLING SYSTEM ELECT. $/YR | HEATING SYSTEM DEMAND $/YR | HEATING SYSTEM ELECT. KWH/YR | HEATING SYSTEM ELECT. $/YR | HEATING SYSTEM GAS MCF/YR | HEATING SYSTEM GAS $/YR |
|---|---|---|---|---|---|---|---|---|
| 100 | 53,714 | 2,055,148 | 43,980 | 2,231 | 91,435 | 1,957 | 1,621 | 7,116 |
| 500 | 15,353 | 695,522 | 14,884 | 378 | 24,992 | 535 | 412 | 1,426 |
| 1000 | 46,120 | 3,631,430 | 77,713 | 16,517 | 165,582 | 3,543 | 13,652 | 47,236 |
| 1300 | 92,165 | 3,337,121 | 71,414 | 5,019 | 228,336 | 4,886 | 6,862 | 23,743 |
| 2200 | 57,276 | 2,229,966 | 47,721 | 6,027 | 82,596 | 1,768 | 4,134 | 14,304 |
| SUBTOTALS | 264,628 | 11,949,187 | 255,713 | 30,172 | 592,941 | 12,689 | 26,681 | 93,824 |
| ANNUAL BOILER & CHILLER SYSTEM ENERGY | | | | 69,487 | MMBTU/YR | | | |
| ANNUAL BOILER & CHILLER SYSTEM COST, $/YR | | | | 657,025 | $/YR | | | |

D. Energy Conservation Opportunity (ECO) Analysis

*ECOs Rejected:* After reviewing the data collected at the facility and considering allof the practical limitations involved, there were no potential ECOs which were rejected prior to performing calculations. Therefore, energy savings calculations were performed for all ECOs identified in the scope of work.

*ECOs Recommended:* Certain ECOs which were identified during the building survey have been evaluated for technical and economic feasibility and are recommended for implementation. Complete documentation of all calculations as well as information required for implementation is included in Appendix B. These recommended ECOs are summarized in order of descending Savings to Investment Ratio (SIR) in Table 1 on page 7 .

*ECOs Not Recommended:* Certain ECOs which were identified during the building surveyhave been evaluated for technical and economic feasibility but are not recommended for implementation. Complete documentation of all calculations are included in AppendixC. These non-recommended ECOs are summarized in order of order of descending SIR in Table 2 on page 8 .

*Projects Developed:* The Project Manager decided to that each of the two recommended ECOs would be implemented as an individual project. The projects that resulted from this process will be submitted for funding as ECIP projects. The projects are summarized as follows:

Project 1: Replacement of Existing Central Boilers with High Efficiency Modular Boilers (Area 2200) - ECO O.

| | | |
|---|---|---|
| Electrical Energy Savings | 7 | MMBTU/yr. |
| Electrical Demand Savings | -171 | $/yr. |
| Natural Gas Energy Savings | 803 | MMBTU/yr. |
| Energy Cost Savings | 2,651 | $/yr. |
| Maintenance Savings | 36,780 | $/yr. |
| Total Cost Savings | 39,431 | $/yr. |
| Total Investment | 311,340 | $ |
| Simple Payback | 7.9 | yrs. |

SIR ?

Project 2: Retrofit Existing Individual Boilers with Central Boiler Plant (Area 100) - ECO C.

| | | |
|---|---|---|
| Electrical Energy Savings | 57 | MMBTU/yr. |
| Electrical Demand Savings | 1,295 | $/yr. |
| Natural Gas Energy Savings | 314 | MMBTU/yr. |
| Energy Cost Savings | 3,031 | $/yr. |
| Maintenance Savings | 91,980 | $/yr. |
| Total Cost Savings | 95,011 | $/yr. |
| Total Investment | 945,482 | $ |
| Simple Payback | 9.95 | yrs. |

SIR ?

E. Recommended Maintenance & Operations Practices

The following maintenance and operations (M&O) practices are recommended to help conserve boiler and chiller plant energy at FSH.

1. The Energy Coordinator and the FSH Director of Public Works should develop a master plan specification for all future central boiler and chiller plant maintenance and renovation projects.

2. All facility project managers, as well as any central plant maintenance contractors shauld be required to follow this specification.

3. The Energy Coordinator should review all new central boiler and chiller plant designs to check for compliance with the specifications. This would include primary equipment that is selected and designed to run at the optimum efficiency points based upon the percentage of full load.

4. The Energy Coordinator should attend training seminars for building energy conservation.

5. The installation should increase the size of their current maintenance staff by adding trained HVAC technicians.

6. The installation should provide technical training for it's current HVAC staff, especially in the area of HVAC controls.

7. Revise the current HVAC preventative maintenance program as needed to improve the overall condition of the existing systems and equipment. This includes the piping distribution systems and any leaks caused by age or wear and tear. The Energy Coordinator should be involved in this process to ensure that energy conservation concerns are addressed.

8. Add status, alarm, start and stop capabilities for all central boiler and chiller systems and auxiliaries to the post's existing building automation system. This will allow the maintenance staff to have better monitoring and control capabilities .

9. Develop a boiler maintenance program that would include, as a minimum, annual tube cleaning, annual or semi-annual burner tuning, and monthly flue stack temperature measurements. The Energy Coordinator should be involved in this process to ensure that energy conservation concerns are addressed.

10. Setback temperatures or shut-off equipment of areas that are unoccupied during the day. In many buildings, especially in Areas 100 and 2200, the air handling systems can be completely shut-off during unoccupied periods without the risk of having a large start-up load which happens in large spaces and buildings.

11. Repair all building temperature controls.

12. Repair all building air systems, cleaning coils and looking for leaks or other sources of inefficiencies within the secondary HVAC systems.

F. Energy and Cost Savings

*Total Potential Energy and Cost Savings*. The energy and cost savings as a result of the implementation of the ECIP projects was calculated as follows:

| | | |
|---|---|---|
| Electrical Energy Savings | 64 | MMBTU/yr. |
| Electrical Demand Savings | 1,124 | $/yr. |
| Natural Gas Energy Savings | 1,117 | MMBTU/yr. |
| Energy Cost Savings | 5,682 | $/yr. |
| Maintenance Savings | 128,760 | $/yr. |
| Total Cost Savings | 134,442 | $/yr. |
| Total Investment | 1,256,822 | $ |
| Simple Payback | 9.3 | yrs. |

SIR = ?

*Energy Usage and Costs Before and After*. Based on the base year electrical and gas energy consumption and cost data, and the potential savings calculated above, the FSH energy usage and costs before and after implementation of the ECIP project is as follows:

| | Before | After |
|---|---|---|
| Electrical | 153,580 MWH | 153,561 MWH |
| Natural Gas | 405,282 MCF | 404,165 MCF |
| Total Cost | $8,257,166 | $8,250,736 |

*Percentage Saved*. Based on the base year electrical and gas energy consumption and cost data, the percentage of savings from the implementation of the ECIP projects is as follows:

$$Electrical\ Energy\ Saved = \left[\frac{18.75\ MWH}{153{,}580\ MWH}\right] = 0.012\%$$

$$Natural\ Gas\ Energy\ Savings = \left[\frac{1{,}117\ MCF}{405{,}282\ MCF}\right] = 0.28\%$$

$$Energy\ Cost\ Savings = \left[\frac{\$6{,}430}{\$8{,}257{,}166}\right] = 0.078\%$$

## TABLE 1. ENERGY CONSERVATION OPPORTUNITIES (ECOs) RECOMMENDED

| ECO | Description | Electrical Energy Savings MMBTU/yr | Electrical Demand Savings $/yr | Gas Energy Savings MMBTU/yr | Total Energy Savings MMBTU/yr | Maint. Cost Savings $/yr | Total Cost Savings $/yr | Total Investment $ | Simple Payback Yrs | SIR |
|---|---|---|---|---|---|---|---|---|---|---|
| | AREA 2200 | | | | | | | | | |
| O | Replace Existing Boilers With High Efficiency Modular Boilers | 7 | -171 | 803 | 796 | 36,780 | 39,431 | 311,340 | 7.9 | 1.92 |
| | AREA 100 | | | | | | | | | |
| C | Retrofit Existing Individual Boilers With Central Boiler Plant | 57 | 1,295 | 314 | 371 | 91,980 | 95,011 | 945,481 | 10.0 | 1.48 |
| | Totals | 64 | 1,124 | 1,117 | 1,167 | 128,760 | 134,442 | 1,256,821 | 9.3 | |

replace?

## TABLE 2. ENERGY CONSERVATION OPPORTUNITIES (ECOs) NOT RECOMMENDED

| ECO | Description | Electrical Energy Savings MMBTU/yr | Electrical Demand Savings $/yr | Gas Energy Savings MMBTU/yr | Total Energy Savings MMBTU/yr | Maint. Cost Savings $/yr | Total Cost Savings $/yr | Total Investment $ | Simple Payback Yrs | SIR |
|---|---|---|---|---|---|---|---|---|---|---|
| | AREA 1000 | | | | | | | | | |
| H | Retrofit Existing Individual Chillers With Central Chillers | 1,016 | 3,865 | 0 | 1,016 | 27,480 | 37,885 | 480,090 | 12.7 | 1.18 |
| | AREA 1300 | | | | | | | | | |
| K | Replace Existing Individual Chillers With Central Chillers | 4,393 | 43,719 | 0 | 4,393 | 20,243 | 95,249 | 1,441,745 | 13.0 | 1.17 |
| | AREA 100 | | | | | | | | | |
| B | Retrofit Existing Individual Chillers With Central Chiller Plant | 4,350 | 37,558 | 0 | 4,350 | 26,773 | 91,649 | 1,646,927 | 18.0 | 0.83 |
| | AREA 1000 | | | | | | | | | |
| I | Retrofit Existing Individual Boilers With Central Boilers | -28 | -158 | 80 | 52 | 10,380 | 10,323 | 186,539 | 18.1 | 0.83 |
| | AREA 2200 | | | | | | | | | |
| N | Replace Existing Chillers With Central Chillers | 3,050 | 25,570 | 0 | 3,050 | 8,005 | 55,110 | 1,040,094 | 18.9 | 0.80 |
| | AREA 1300 | | | | | | | | | |
| L | Retrofit Existing Individual Boilers With Central Boilers | 342 | 1,256 | 1,064 | 1,406 | 15,180 | 22,265 | 484,544 | 21.8 | 0.71 |
| | AREA 500 | | | | | | | | | |
| F | Retrofit Existing Individual Boilers With Central Boilers | -109 | -329 | 79 | -30 | 7,980 | 7,240 | 164,799 | 22.8 | 0.66 |
| | AREA 500 | | | | | | | | | |
| D | Install Energy Management (EMS) for HVAC System | 1,957 | -401 | 39 | 1,996 | 0 | 12,024 | 278,393 | 23.2 | 0.65 |
| | AREA 100 | | | | | | | | | |
| A | Install Energy Management (EMS) for HVAC System | 5,928 | -2,523 | 691 | 3,876 | 0 | 37,738 | 928,408 | 24.6 | 0.62 |
| | AREA 2200 | | | | | | | | | |
| M | Install Energy Management (EMS) for HVAC System | 5,002 | -1,740 | 124 | 5,126 | 0 | 30,102 | 889,460 | 29.6 | 0.51 |
| | AREA 500 | | | | | | | | | |
| E | Retrofit Existing Individual Chillers With Central Chillers | 705 | 3,743 | 0 | 705 | 9,080 | 17,250 | 516,826 | 30.0 | 0.50 |
| | AREA 1300 | | | | | | | | | |
| J | Install Energy Management (EMS) for HVAC System | 3,105 | -471 | 915 | 4,020 | 0 | 22,194 | 970,739 | 43.7 | 0.36 |
| | AREA 1000 | | | | | | | | | |
| G | Install Energy Management (EMS) for HVAC System | 832 | 149 | -94 | 838 | 0 | 5,049 | 266,445 | 52.8 | 0.28 |
| | Totals | 15,572 | -842 | 1,636 | 14,565 | 9,080 | 112,333 | 3,571,878 | 31.8 | |

## II. NARRATIVE REPORT

A. Entry Interview

*Work Plan:* An entry interview meeting was conducted at the Fort Sam Houston (FSH) facility on October 16, 1995. Present at the meeting were representatives of Huitt Zollars Inc. (HZ), Chris Pieper, P.E., *Project Manager*, John Carter, E.I.T., *Mechanical Engineer*, and M.A. Shafiq, P.E., *Mechanical Engineer*, as well as representatives from FSH, Frank Carbonell, *FSH Engineering Services Branch* and Mike Brynes, *FSH Maintenance and Operations*. During the meeting, a description of the work plan for this study was presented. The work plan was a summary of the individual tasks to be performed to complete the boiler & chiller study and the approximate date that each task was to begin. Each step of the work plan was described in detail to the FSH staff. The proposed work plan is shown in Figure 4.

**Figure 4. Work Plan**

| | |
|---|---|
| 10/16/95 | Entry Interview |
| 10/16/95 | Building & Systems Data Collection |
| 10/30/95 | Formulate ECOs & Perform Calculations |
| 1/29/96 | Interim Findings Submittal |
| 3/29/96 | Pre-Final Report Submittal |
| 5/31/96 | Final Report Submittal |

*Data List:* After discussing the work plan, the FSH staff was presented a list of data items to be collected by the study team, shown in Figure 5. This list was a summary of the information required by the surveyors. The study team and FSH staff discussed the methods by which all of the data on the list were to be obtained. The data concerning the existing boiler and chillersystems were to be collected from the buildings and recorded onto preprinted data forms. Building mechanical drawings were to be collected, information extracted, site verified, and included on individual building data forms. All data forms are included in Appendix G (Tab 7). The FSH personnel provided direction as to where to obtain information on the list. They also provided useful information on past energy conservation efforts and current design projects. One such project is the proposal to install a base wide EMS to control primary and secondary HVAC equipment in many of the buildings on post. This project has been designed but has not been implemented.

**Figure 5. Data Acquisition List**

1. Existing central boiler and chiller systems.
2. Existing auxiliary systems in central plants.
3. Existing plant and building control systems.
4. Building HVAC system types and operational schedules.
5. Building size, age, and remaining useful life.
6. Existing building operational schedules and area usage.
7. Facility 12 month gas billing history ( August 93' - July 94' ).
8. Typical maintenance and retrofit procedures and costs.
9. Building envelope descriptions.
10. Building internal cooling loads.

*ECO List:* Following the discussion on the data list, the FSH personnel were presented a list of specific Energy Conservation Opportunities (ECOs) that were identified for evaluation in the Detailed Scope of Work (see Appendix D, Tab 4). This list is shown in Figure 6. The first ECO specified was the upgrade or replacement of existing central chillers with more efficient systems whichincludes possibly installing or upgrading the DDC control systems. The scope specifically called for the evaluation of gas enginevs. electrical

driven compressors, drive configuration, and variable speed drivers for the chillers. All of these types and configurations were evaluated as a means of saving energy and maintenance costs in the existing central chiller plants of areas 500, 1000, 1300 and 2200. The second ECO specified was the upgrade or replacement of existing central boilers with more efficient systems which includes possibly installing or upgrading the DDC control systems. Since no specific types were identified, the most efficient alternatives were selected and evaluatedas a means of saving energy and maintenance costs in the existing central boilerplants of areas 500, 1000, 1300 and 2200. The third ECO specified was the installation of new central chillerplants to replace existing individual building chillers. These new central plant evaluations were similar to a 1986 central plant design for area 100 which was never implemented. The fourth ECO specified was the installation of new central boiler plants to replace the existing individual building boilers. In allECOs, the annual energy consumption of the boilers, chillers and auxiliary equipment were calculated by computer simulations using the Trane Trace 600 program. Building data were used to accurately model each building such that a realisticload profile was created for simulating boiler and chilleroperational patterns. In all ECO calculations, the required capacity of the existing central heating and cooling equipment was evaluated from the computer simulations and recommendations for proper sizing were made.

**Figure 6. Specific ECO List**

1. Chiller Replacement or retrofit with and without installing new control systems
2. Boiler upgrade or replacement with and without installing new control system.
3. Install central chiller plants with and without installing new control systems.
5. Install central boiler plants with and without installing new control systems.

B. Data Collection.

Following the entry interview, the study team began the task of collecting the required data. First, building mechanical plans were studied and data was extracted. Field surveys were made on all of the buildings in the study to verify and supplement data collected from the drawings. Al of the data obtained from drawings and field survey was documented in data sheets and included in Appendix G (Tab 7). The following summarizes the data collection phase of this study.

*Building Data:* This study was performed on five separate groups of buildings. These groups were identified as areas 100, 500, 1000, 1300, and 2200. Buildings in each of these areas are described as follows:

1. Area 100 - This area included buildings 122, 123, 124, 125, 126, 127, 128, 129, 131, 132, 133, 134, 135, 140, 141, 142, 143, 144, 145, 146, 147, 149, 151, 152, 154, 155, 156, 157, 158, 159, 197, 198, 199, 250, 260, 261, and 268. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. Most of the buildings in this area are historical landmarks which were built around the Second World War, and some as early as the First World War. The buildings built at that time consisted of wood framed structures with a brick veneer exteriors, pitched shingle roofs, and pier and beam foundations. Most of the buildings had basements and attic spaces. These buildings are currently used as office buildings, barracks, and other miscellaneous functions including a band rehearsal hall and museum. Each building is occupied by both Army and civilian personnel.

2. Area 500 - This area included Buildings 590, 591, and 592. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. These buildings are used for Unaccompanied Personnel Housing (UPH). Buildings 590 and 591 are exact replicas of each other. They both were built in 1956 with masonry structures, stucco exteriors, and a clay tile roof. The buildings are three stories with a gross area of 21,940 sqft. Building 592 also is used for UPH; however, it is larger than the other two, and built at a later date (1971). It is five stories and has a gross area of 127,537 sqft. Building 592 consists of two person rooms while the other two buildings are only one person rooms. The structure of building 592 consists of masonry walls with a brick exterior and a flat, built-up roof.

3. Area 1000 - This area included buildings 1000, 1001, and 1029. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. Buildings 1001 and 1029 are both office buildings. Building 1001 includes the Brooke Army Medical Center clinics, medical library, Emergency Transport Services (EMT), and pastoral care services. With the exception of the library and the EMT, it has a continuous occupancy between 7:30 A.M. and 5:00 P.M. Building 1029 is the Headquarters for Brooke Army Medical Center. It also has a continuous occupancy between 7:30 A.M. and 5:00 P.M. Both of these structures are four stories and have a brick exterior masonry wall. Building 1000 is the Brooke Army Medical Center. It is a seven story hospital built in the 1930's with a total gross area of 227,302 sqft. The existing structure is masonry with exterior brick walls. It is important to note that the functions within this building will eventually move to a new facility that is currently under construction. However, for the purposes of this study, we will model and analyze the building as it currently exists.

4. Area 1300 - This area included buildings 1350, 1374, 1375, 1379, 1380, 1382, 1384, 1385, 1387, 1396, and 1398. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. The buildings in this group consisted of seven barracks, one dining hall, one theater, one chapel, one mini-mall, and one administrative office building. Most of the buildings were constructed between 1971-1972 with the exception of buildings 1350 and 1387 which were built in 1983 and 1988 respectively. All of the barracks (Buildings 1350, 1374, 1375, 1379, 1380, 1382, and 1384) were multi-story structures while the remainder of the buildings were single story structures.

5. Area 2200 - This area included buildings 2200, 2244, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272, 2273, and 2288. A map of this area is included in Appendix G (Tab 7) along with the data sheets for these buildings. The buildings in this group consisted of three barracks, one chapel, one theater, the military police station, and six administrative office buildings. Building 2288 is a building that has been committed by Congress for disposal within the year. Therefore, we will not recommend this building to be included in any ECO's developed for this area. All of these buildings are primarily masonry structures with brick stucco exteriors and pitched roofs.

*Central Plant & HVAC Systems Data:*

1. Area 100 - The buildings in this area have no central boiler or chiller plant. All of the buildings have stand alone primary heating and cooling systems that serve a maximum of two buildings each. The primary cooling systems consist of eighteen (18) ACR chillers, five (5) condensing units, sixty four (64) window units, and six (6) packaged AHU's with a total of approximately 835 tons. Most of the chillers appeared to be in good condition. However, the packaged systems and window units are in poor condition and need to be replaced. They are not only

a maintenance problem but they are also very inefficient.

The primary heating systems consisted of nineteen (19) HW boilers, two (2) steam boilers, seventeen (17) space heaters and furnaces, and forty seven (47) window units with a combined capacity of approximately 10,720 MBH. Most of the boilers appeared to be in good condition. However, the space heaters, window units and furnaces are in poor condition and need to be replaced. Additionally, the window units and some of the space heaters utilize electric resistance heat which is very inefficient and should be avoided because natural gas is available on site and is more economical to use.

Chilled water and hot water pumps are generally located within the buildingsthat they serve. Domestic Hot Water is generated by individual gas fired water heaters in each basement.

Secondary HVAC systems in these buildings consist of two-pipe and four-pipe multi-zone and single zone AHUs, FCUs, packaged systems, and window units located within the buildings. As described above for the primary equipment, there are both DX systems and CHW systems for cooling, and steam and HW for heating. Most of the air side equipment is located in mechanical rooms with the exception of a few areas where the units are hung above the ceiling.

With the multiplicity of air handling systems and renovations made to these systems, controls in this area are very difficult to maintain. Most of the single zone AHUs and FCUs that are served by CHW and HW have three way control valves serving the units. These are modulated, in some cases with face and bypass dampers, to maintain space temperature or leaving air temperature setpoints. Most of the multi-zone AHUs that are served by CHW and HW have three-way control valves that are modulated to maintain leaving air temperature setpoints. The zone dampers are then modulated to maintain space temperatures. The window units and packaged systems are typically controlled by manual on/off switches or thermostats. As mentioned above, many of the control valves for these units and thermostats are inoperable or appear to have been disconnected. Therefore, space temperatures are very difficult to maintain and the units currently operate when the buildings are unoccupied.

2. <u>Area 500</u> - Each of the three buildings in this area has it's own primary chilled water system Buildings 590 and 591 are identical not only in architectural appearance but also in mechanical systems (with the exception of the size of the HW boiler). One (1) 60 ton air cooled reciprocating chiller located on the East side of each building serves three (3), four-pipe, multi-zone AHUs. Building 592, on the other hand, is served by one (1) R-123, 170 ton water cooled centrifugal chiller. This chiller serves five (5), four pipe, multi-zone AHUs.

Heating is provided by HW boilers located in each building. In buildings 590 and 591, 525 and 850 MBH water tube HW boilers, respectively, supply the three (3) AHUs. Building 592 has a 2,750 MBH water tube HW boiler supplying it's five (5) AHUs. All of the boilers have hot water reset control that has been de-activated.

Secondary systems in the buildings consist of four-pipe, multi-zone AHUs. These AHUs do not use ducted return but corridor return and/or plenum return above the corridor ceiling space. As a result, the mechanical rooms in the buildings are plenum spaces with return grilles in the doors or in the walls. Also, the units on the first floor are larger than the units on the rest of the floors because of the larger conditioned area.

The chilled water systems in Building 590 and 591 have very little control. It appears that the chillers are cycled on and off according to the chilled water return temperature. In the buildings, the three AHUs have no control on the chilled water coils, and thus run wild. The heating water system operates in a similar fashion but there is a three-way mixing valve on the primary side. This control valve and the boiler are modulated in sequence to maintain the heating water supply temperature. The heating water coils for the AHUs are also wild. Therefore, the face and bypass dampers are modulated to maintain the leaving air temperature setpoint while a controller modulates the zone dampers to maintain the space temperature setpoint. The air handling systems in Building 592 are controlled exactly like the other two buildings with the exception of three-way control valves on the HW coils. These control valves are modulated with the face and bypass dampers to maintain leaving air temperature. On the primary side, a water cooled centrifugal chiller is controlled to maintain chilled water supply temperature. The cooling tower fan is cycled, and the bypass valve is modulated to maintain condenser water temperature. The boiler is controlled similarly to the other two buildings.

3. <u>Area 1000</u> - The three buildings in this area are all served by water cooled centrifugal chillers However, Building 1029 is the only one of the three that has it's own primary chilled water system. Building 1001 is served by one (1) R-11, 219 ton chiller and cooling tower located in Building 1002. Building 1000 has two (2), R-11, 400 ton centrifugal chillers located in the chiller plant, Building 1088, which are served by two (2) cooling towers located on the roof of that plant. Both of these chillers are approximately five years old and are in very good shape. Building 1029 is also served by a new chiller and it is one year old. This 160 ton chiller is served by an older cooling tower that appears to be undersized for the new chiller. The cooling tower is located on the roof of Building 1029.

Heating systems in Building 1000, the main hospital, consist of both steam and HW systems Three 15 psig, 5,223 MBH steam boilers serve radiators throughout the Hospital. These boilers are only operated in the winter period. Three 5,500 MBH flextube HW boilers provide heating for the remainder of the building. There are also two 60 psig, steam boilers that serve the sterilizers, kitchen equipment, and humidifiers in the building. The heating system serving Building 1001 consists of one 1,050 MBH steam boiler located in the basement. This is the only boiler out of three that is operating. Building 1029 is served by a 2,500 MBH HW boiler located in the basement of the building.

Secondary systems in the buildings include single zone and multi-zone AHUs in all of the buildings, and FCUs in Building. 1000. In Buildings 1001 and 1029, four-pipe multi-zone units serve the bottom floors and four-pipe single zone units serve the top floor. With Building 1000 being a hospital, the air handling systems are more complicated than would be for the typical office or barrack. For example, many of the unit types, as mentioned above, have humidifiers in the ductwork to maintain the humidity control in the critical spaces, ie. operating rooms, burn unit, etc... Also, there are three 100% outside air units that provide outside air to the 492 fan coil units located throughout the building. As mentioned above, there are steam convectors throughout the building to handle some of the heating load.

For CHW system controls in Buildings 1001 and 1029, all of the AHUs have wild CHW coils and face and bypass dampers. For the multi-zone units, the face and bypass dampers are modulated to maintain leaving air temperature setpoint, while the zone dampers are modulated to maintain space temperature setpoint. For the single zone units, the space temperature setpoint controls the operation of the face and bypass dampers. The primary heating systems in the two buildings consist of three-way control valves on the HW coils in Building 1001, and

two-way valves on the steam coils in Building 1029. In the winter, these valves are modulated in sequence with the face and bypass dampers, to maintain leaving air temperature for the multi-zone units. For the single zone units, the space temperature setpoint controls this sequence. The controls for Building 1000 have to maintain the strict requirements of a hospital so they are typically much more involved than previously described for other buildings. On the primary side, the chillers are operated to maintain the supply CHW temperature setpoint, and the cooling tower fans and bypass valve to maintain the condenser water supply temperature setpoint. The three boilers are staged and modulated in unison to maintain the heating water supply temperature setpoint. On the building side, the operating rooms are served by variable air volume AHUs which have two-way valves on the preheat, cooling, and heating coils that are generally controlled to maintain the leaving air temperature setpoint. Humidifiers are located in the AHU, and in the multiple zones. The humidifiers are cycled by a local humidistat to maintain the respective relative humidity setpoint. Space temperature andpressurization are maintained by controlling zone dampers and reheat coils. The critical care areas utilize the same control sequence, except enthalpy control is used to maintain a mixedair temperature entering the unit. The Lab multi-zone AHUs have both a cold deck and a hot deck. The two-way control valves are modulated to maintain the leaving coil temperature setpoint. The space thermostats modulate the zone mixing dampers to maintain setpoints. Enthalpycontrol is utilized to maintain a mixed air temperature setpoint and also modulatesthe heating coil valve to account for the variance in mixed air temperature. Overall, the primary equipment controls are in good condition; however, those controls are limited to generally the air handling equipment only. Therefore, there is no sequencing or load optimization ofprimary equipment other than what the manufacturer of the equipment provided. On the building side, many of the controls in Buildings 1001, and 1029 are de-activated , and need to be replaced or repaired. The controls for the air side systems in Building 1000 appear to be operating and in good condition for the age of the equipment.

4. Area 1300 - Eight of the buildings (1350, 1374, 1375, 1377, 1379, 1380, 1382, 1385) in this area are served by a central plant adjacent to Building 1377. The other four (4) buildings (1384, 1387, 1396, & 1398) are controlled by stand-alone systems. The primarycooling system in Building 1377's plant consist of two (2) centrifugal water cooled chillers, rated at a combined 986 tons, which are 23 years old and use R-11 refrigerant. These two chillers are piped in series and serve all of the buildings in that group except for 1350. This newer building is served by one (1) 438 ton, water cooled centrifugal chiller that is 12 years old and uses R-11 refrigerant. A 12 year old, single-cell cooling tower serves this chiller while a 23 year old, and one (1) two-cell tower serves the other two chillers. The older chillers and tower appeared to be in poor condition and nearing the end of useful life. The newer chiller andtower were in fair condition with some years of useful life remaining. For the other stand-alone buildings, one (1) R-11, 273 ton water cooled centrifugal chiller serves Building. 1384. This chiller is 23 years old, and is served by a cooling tower that appears to be 3 years old and in good shape. Building 1387 is served by 97 tons of split system heat pumps. These systems are approximately eight years old and are in good shape. Building 1396 is served byone (1) 50 ton packaged DX air handling unit with a remote condenser, and one (1) 7.5 ton split system. The packaged system is approximately 20 years old and is close to the end of it's useful life while the split system appears to be in good shape. Lastly, Building 1398 is served by one (1) 44 ton reciprocating chiller and remote condenser that is approximately 21 years old. This system also appears to be near the end of it's useful life.

The primary heating system in the first group of buildings consists of two (2) firetube, HW boilers which are 23 years old and have a combined output capacity of 11,824 MBH. These

two boilers serve all of the buildings except for Building 1350. This building is served by two (2) watertube, HW boilers which are 12 years old and have a combined output capacity of 9,653 MBH. The older boilers appeared to be in poor condition and are near the end of their useful life. The newer boiler was in fair condition with some years of useful life remaining Again, the four other buildings are served by isolated heating systems. Three of the buildings (1384, 1396, and 1398) are served by water tube HW boilers that total 4,445 MBH output capacity. All three of the boilers in this area appear to be approximately 10 years old and in good shape. The fourth building, as mentioned above, is equipped with air handling systems consisting of split system heat pumps with auxiliary electric resistance heat.

Secondary HVAC systems in these buildings consist of two pipe FCUs, heat pumps, two-pipe single zone AHUs, four-pipe multi-zone AHUs, and packaged AHUs . All of the buildings that are served by the central plant in Building 1377 have secondary CHW and HW pumps to circulate water from the central loops to all the FCUs and air handlers.

The primary chilled water system from the central plant in Building 1377 consists of two centrifugal chillers, piped in series, which are cycled on /off to maintain the CHW supply temperature setpoint of the respective chiller. Each chiller has it's own controller and operates independent of the other. The third chiller located in the addition to the plant is also cycled on / off to maintain the CHW supply temperature of the chiller. This chiller was designed to serve Building 1350 but is also connected to the other loop with crossover valves. This plant serves both two-way and three-way CHW valves on the air handling systems. Building 1350 is equipped with four-pipe, dual duct, variable air volume AHUs that have both a cold deck and hot deck controlled to maintain the leaving air temperatures of the respective coil. Zone dampers are modulated to maintain space temperatures. The remainder of the buildings served by this plant have multi-zone units that have three-way controlled HW coils, both three-way controlled and wild CHW coils, and some face and bypass dampers. For all the units, space temperature setpoints are maintained by modulating the zone dampers, and leaving coil temperature setpoints are maintained by modulating the HW or CHW valves, and face and bypass dampers (as applicable). Building 1384 has a primary CHW system that consists of a chiller that is controlled to maintain CHW supply temperature, and wild CHW coils throughout the system. The HW system consists of a boiler which is modulated in sequence with a three-way mixing valve to maintain HW supply temperature setpoint. Each AHU is equipped with three-way HW control valves on the coils. The control valves serving the coils are modulated to maintain the leaving air temperature setpoint while the space temperature is maintained by modulating the zone mixing dampers. Building 1387 has split DX heat pump systems. These units are cycled on /off by space thermostats. Building 1396 has one packaged system with a heating coil and a DX compressor. The compressor is staged to maintain supply air temperature and space temperature. The other split system AHU is controlled to maintain the space temperature setpoint. Building 1398 has a two-pipe system where the chiller and boiler are controlled to maintain the supply temperature setpoint. The two-pipe FCUs have mixing valves that are controlled by space thermostats. Overall HVAC system performance in this area is poor due largely to faulty or inadequate controls. Many of the controls have been disconnected or no longer operate correctly.

5. <u>Area 2200</u> - Four of the buildings (2263, 2264, 2265, & 2266) in this area are served by a central CHW plant in the basement of Building 2265 while the other buildings are served by isolated systems. The central plant in Building 2265 consists of a single 650 ton centrifugal water cooled chiller, which is 22 years old and uses R-11 refrigerant. A 23 year old, single cell, built-up cooling tower serves this chiller. The chiller and tower appear to be in poor

condition and nearing the end of useful service. The other buildings consist of 267 tons of air cooled chillers, window units, or open drive reciprocating chillers. Most of the air cooled chillers are in good shape, but the open drive reciprocating machines and window units are reaching the end of their useful service and need to be replaced.

The primary heating systems consist of nine watertube, HW boilers which have a combined rated capacity of 9,830 MBH, and one steam boiler serving Building 2247 with a capacity of 80 MBH. Most of these boilers, except the steam boiler, appeared to be in good condition with many years of useful life remaining. The steam boiler is not only very old, but it has been damaged by flood water from the sanitary sewer system. Therefore, this boiler needs to be replaced.

A variety of secondary systems serve the buildings studied in this area including single zone, multi-zone, DX, packaged AHUs, and FCUs. In addition, many of the buildings are either two-pipe or four-pipe, or combinations of the two. Several of the buildings' AHUs are located in areas that are difficult to access for maintenance. Buildings 2200 and 2247 are prime examples Building 2200 has AHUs located in the under-floor crawlspace and have very little clear space to access. Building 2247, on the other hand, has an AHU located above the ceiling space in the restroom, which requires part of the ceiling grid removed to maintain the equipment.

Both of the primary CHW and HW systems that serves Buildings 2263 through 2266 have three way control valves on the air handling unit coils. The centrifugal chiller is modulated to maintain the CHW supply temperature, while it appears the cooling tower fan and bypass valve are controlled to maintain CW supply and return water temperature setpoints respectively. The three HW boilers have primary mixing valves to maintain the HW supply setpoint. Also, each building has HW booster pumps in the loop. These four buildings are primarily served by single zone units with face and bypass dampers or multi- zone units. For the single zone units, the space thermostats modulated the three-way valve, depending on summer or winter operation, and face and bypass dampers to maintain space temperature setpoint. For the multi-zone units, the coil valves are modulated to maintain leaving air temperature from the coil, while the space temperature controls the zone dampers. The other buildings are served by individual air cooled chillers or DX systems. The systems are cycled on / off to maintain the CHW supply temperature setpoint. In addition, there are various control strategies used. All of the air cooled chiller systems have either wild CHW coils or three-way control valves on the coils, and the DX systems have two-way solenoid valves. For the HW loops, the primary equipment utilize both steam and HW boilers. All of the HW boilers maintain the HW supply temperature setpoint and have one firing rate. The steam boilers on the other hand appear to operate to maintain the steam pressure. For all HW systems, the individual boilers serve both three-way controlled coils and wild coils. The multi-zone or single zone units in these buildings operate similarly those mentioned above, and the FCUs have both wild coils with no thermostatic control and three-way coils controlled via space thermostats. Overall HVAC system performance in this area is poor due in part to faulty controls. As seen in all the areas, much of the controls have been de-activated or they appear to be malfunctioning.

*Maintenance and Operations Data:* Most of the HVAC system routine preventive maintenance is performed by post Civil Service personnel in the DPW. In general, post maintenance appears to be inadequate due to the lack of manpower in the maintenance department. For instance, some HVAC air filters appeared to be excessively dirty and/or installed backwards. Leaks were found in the HW coil of one air handler, and many actuators for dampers or valves have been broken off or disconnected. HVAC system controls also appeared to be inoperable or missing, adding to the inability of the systems

to maintain temperatures within the building spaces. In many buildings, the outside air dampers to the AHU's were either manually shut and disconnected or in some cases the outside air louvers were blocked off.

The maintenance department has a procedure to keep up with the general maintenance of the equipment For the CHW systems, a daily log is kept of the operation of the chillers. This log records temperatures, pressures, amperage, etc. Refer to Appendix F (Tab 6) for a typical chiller log. A complete walk-through of the system is performed once a month. This involves checking gages, valves, etc. Once a year, the maintenance department cleans and maintains the cooling towers which includes a thorough wash down, and a belt change. Also, once a year, the air cooled chillers have a complete wash down, and a preventive maintenance check. For the HW systems, most of the maintenance is done an as needed basis. However, there is an open and/or closed inspection of the boilers performed every six months which could then result in more detailed maintenance if needed. One of the drawbacks for not having a regular maintenance program for the boilers is that there is not a periodic recording of the flue stack temperatures, which is something that is recommended.

For specific annual maintenance on the water cooled chillers, the base has contracted an outside company (Gillette Corp.) to handle this work. This contract, known as the Gillette Contract, includes, among other items, cleaning the condenser coil, changing the oil and the filters, and inspecting the purge system. It also includes three (3) major overhauls per year. For a description of this maintenance program, refer to Appendix F (Tab 6). If there is any maintenance required (other than major overhauls) that is above the scope of the contract, FSH is only charged for the parts. However, for any *major overhauls* above the allotted amount in the contract, FSH is charged for both parts and labor. Currently, there are 15 chillers included in this contract with plans to add additional chillers (Buildings1029, and 592) once the warranty period from the manufacturer has expired. The total cost for maintaining these chillers during the 1994-1995 contract year was $148,000. This averages out to be approximately $12,150 for each chiller. There is a second contractor (Calgon Corporation) that maintains the water treatment for both the CHW and HW system. The details of these services can also be seen in Appendix F (Tab 6).

Most of the primary CHW and HW systems in the buildings studied are operated on a seasonally basis. The cooling season is typically from May to October and the heating season from November through April. This, however, varies from year to year according to the severity of the seasons. There are a few exceptions to this policy which include Buildings 268, 1000/1088, 2200, 2244, and 2247. In these buildings, the chilled water systems operate year round, and the heating water and HPS systems that serve building 1000 operate year round. For a large percentage of the buildings studied, the outside air intake has been significantly reduced or shut-off completely, and this is not in accordance with the ventilation requirements of ASHRAE Standard 62-89. Also, many of the automatic controls are no longer working. Of all the buildings studied that had outside air economizer control, it appeared to no longer work (except Building 1000). As a result, in most to all cases, it appeared that the air handling units operated without any shut-off, night setback, or economizer control.

*Recommended Maintenance & Operations Practices:* The following maintenance and operations (M&O) practices are recommended to help conserve boiler and chiller plant energy at FSH.

1. The Energy Coordinator and the FSH Director of Public Works should develop a master plan specification for all future central boiler and chiller plant maintenance and renovation projects

2. All facility project managers, as well as any central plant maintenance contractors should be required to follow this specification.

3. The energy coordinator should review all new central boiler and chiller plant designs to check for compliance with the specifications. This would include primary equipment that is selected and designed to run at the optimum efficiency points based upon the percentage of full load.

4. The energy coordinator should attend training seminars for building energy.

5. The installation should increase the size of their current maintenance staff by adding trained HVAC technicians.

6. The installation should provide technical training for it's current HVAC staff, especially in the area of HVAC controls.

7. Revise the current HVAC preventative maintenance program as needed to improve the overall condition of the existing systems and equipment. This includes the piping distribution systems and any leaks caused by age or wear and tear. The Energy Manager should be involved in this process to ensure that energy conservation concerns are addressed.

8. Add status, alarm, start and stop capabilities for all central boiler and chiller systems and auxiliaries to the post's existing building automation system. This will allow the maintenance staff to have better monitoring and control capabilities than they currently have.

9. Develop a boiler maintenance program that would include, as a minimum, annual tube cleaning, annual or semi-annual burner tuning, and monthly flue stack temperature measurements. The Energy Manager should be involved in this process to ensure that energy conservation concerns are addressed.

10. Setback temperatures or shut-off equipment of areas that are unoccupied during the day. In many buildings, especially in Areas 100 and 2200, the air side systems can be completely shut-off during unoccupied periods without the risk of having a large start-up load which happens in large spaces and buildings.

11. Repair all building temperature controls.

12. Repair all building air systems, cleaning coils and looking for leaks or other sources of inefficiencies within the secondary HVAC systems.

*Utility Data:* A 12 month utility billing history was obtained from the energy coordinator which covered the period from August, 1993 through July, 1994. This history included all of the metered electric and gas consumption for the installation. This history is shown in Figure 7. The total cost of electricity for the base year was $6.5 million and the total cost for gas was $1.7 million. It is important to note

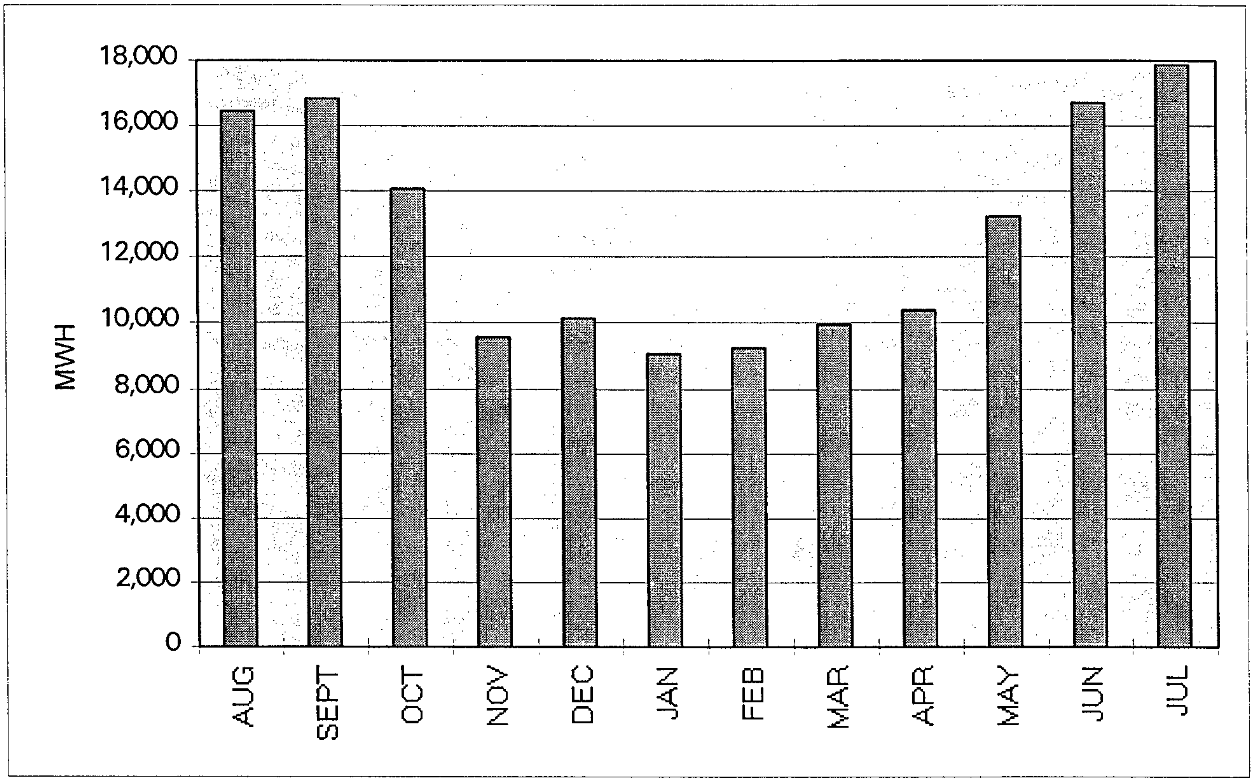
that the total cost indicated above includes only the consumption charges for both gas andelectricity and demand charges for electricity. The actual bills for these months were, in some instances, more than that charged just for electricity and gas usage. For instance, the total gas billing in June, 1994, was $20,730 more than the consumption for that month. However, the additional charges were due to construction cost for relocating some existing gas lines. Therefore, that additional cost for items other than energy usage was not included in the savings calculated for the ECOs.

**Figure 7. Base Year Utility Data**

| Billing Period | Electrical | | | Natural Gas | |
|---|---|---|---|---|---|
| | Demand KW | Consumption MWH | Cost $ | Consumption MCF | Cost $ |
| AUG | 30,576 | 16,464 | $785,463 | 17,063 | $75,149 |
| SEPT | 31,024 | 16,856 | $795,130 | 15,835 | $74,165 |
| OCT | 30,240 | 14,084 | $706,204 | 16,447 | $74,845 |
| NOV | 27,496 | 9,548 | $464,806 | 52,235 | $214,472 |
| DEC | 24,819 | 10,136 | $464,187 | 47,671 | $210,305 |
| JAN | 24,819 | 9,044 | $379,870 | 73,604 | $297,992 |
| FEB | 24,819 | 9,268 | $391,687 | 61,755 | $247,346 |
| MAR | 24,819 | 9,968 | $459,976 | 44,290 | $187,764 |
| APR | 24,819 | 10,416 | $376,714 | 24,458 | $99,261 |
| MAY | 27,160 | 13,216 | $447,478 | 20,588 | $81,904 |
| JUN | 31,752 | 16,716 | $620,912 | 16,192 | $63,594 |
| JUL | 32,872 | 17,864 | $674,674 | 15,144 | $63,268 |
| Total | 335,215 | 153,580 | $6,567,101 | 405,282 | $1,690,065 |

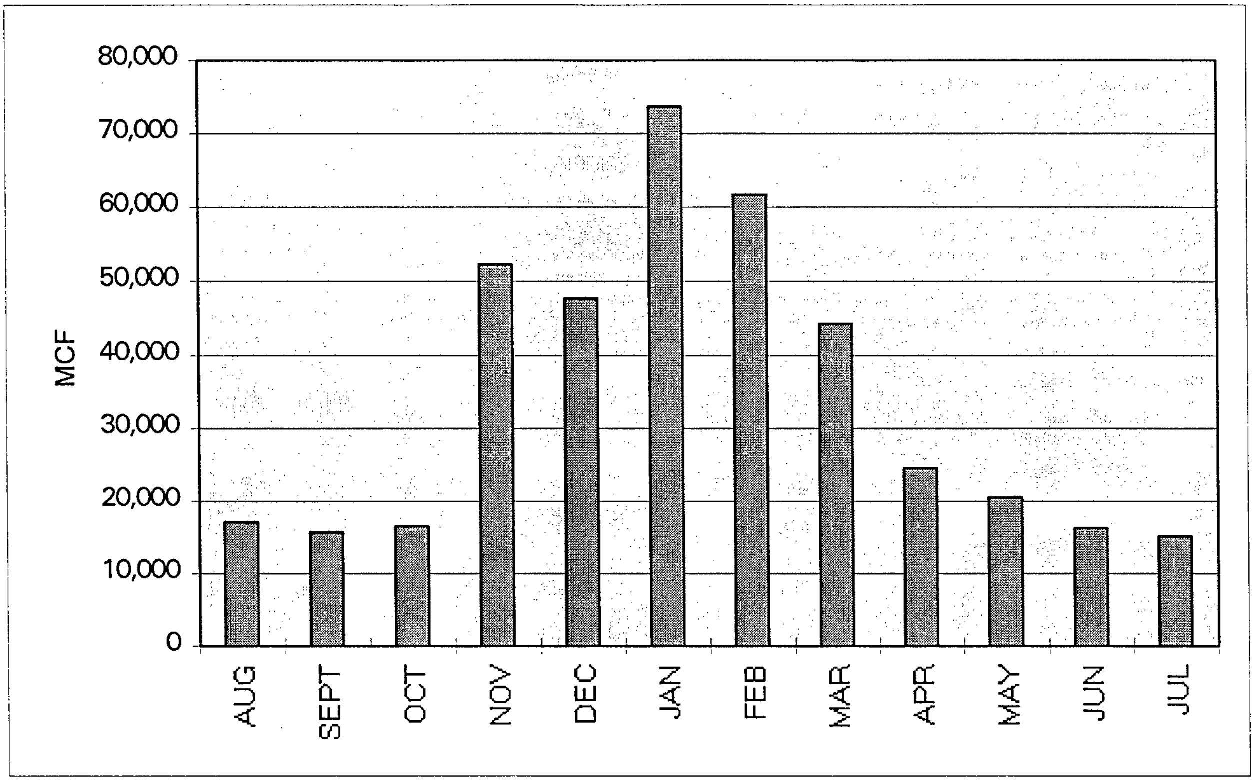
Charts of the base year energy usages were plotted and are shown in Figures 8 and 9. These charts give a visual representation of the installation's energy usage patterns for the year. Looking at Figure 5, it can be seen that the electrical usage never falls below 9,000 MWH per month. This is considered a 'baseline' of electrical energy use. It can be assumed that all energy usage above this baseline is consumed by cooling systems, based on the peaks and the months in which they occur.

Figure 8 - Base Year Electrical Usage Profile




Similar observations can be made about gas energy usage, shown in Figure 9. The baseline usage here is around 15,000 MCF of gas per month. Since gas is the primary source of heating at FSH, the obvious peak during the winter months can be considered heating energy. Therefore, all gas energy usage below the baseline is used for DHW and cooking equipment. This is a large amount of energy usage and should be considered a large target for potential energy savings.

**Figure 9 - Base Year Gas Usage Profile**




Based on the current gas and electric utility rates from the City Public Service (CPS) of San Antonio, the current avoided costs for electrical savings are $0.021 per KWH, and $7.50 to $10.00 per KW demand savings, depending upon the time of year. For natural gas savings for rate G (Domestic and Commercial cooking, heating, and lighting purposes), the avoided cost is $4.39 per MCF. For rate B (Heating and Cooling plants), the avoided cost of gas savings is $3.64 per MCF. There are currently no rebates available from the CPS for boiler or chiller energy conservation projects.

*Replacement Boiler Selection*: Data on available replacement boilers were obtained from typical manufacturers in order to select representative boilers for ECO evaluations. This data included performance characteristics, physical dimensions and cost figures. The criteria for selecting new boiler systems for the ECOs are described below.

1. Efficiency. Replacement boilers that had the highest overall efficiency over the operating range were selected in each area. In most cases, this criteria was met by the high-efficiency modular boilers which were modeled in the ECOs. These are fully condensing, forced draft firetube units that have efficiencies in the 90% range over the entire range of operation. No other boiler type was found to match this performance.

2. Turn-down ratio. In order to limit the thermal shock and efficiency losses associated with cycling, replacement boilers for the ECOs needed to have a high turn-down ratio. The 14:1 ratio associated with the modular boilers used in most ECOs was as good or better than other available boilers with lower efficiencies. And the modular concept of using multiple boilers to match the heating loads, combined with this high turn-down ratio, minimizes the negative impacts of cycling.

3. Controls. In order to closely match the heating load requirements at any given time, all new boilers were selected with fully modulating controls. Two-position or multi-stage controls would increase the possibility of boiler cycling, as well as reduce the part load efficiency.

4. Physical size. In order to fit the new boilers into the buildings without modifying the existing boiler room openings, the small footprint and overall size of the modular boilers was the best choice for the ECOs. Other types of boilers were larger and would require more effort and cost to install in the buildings. This criteria was not a factor in areas 100 and the Quadrangle, where completely new central boiler plants were being considered.

5. First cost. The first cost of the modular boilers was greater than other types available. However, the efficiency improvements of these units justified the higher initial first costs in the Life Cycle Cost Analysis. In areas 100 and the Quadrangle, the first cost of the boilers selected was equivalent to or lower than most of the other boiler types available for the ECOs.

6. Maintenance requirements and costs. All types of replacement boilers would require annual cleaning of the heat exchanger surfaces, as well as optimization of the combustion systems. The boilers used in the ECOs appeared to be as good or better than all other boiler types in ease of maintenance. This is due to their small physical size and construction features. Maintenance cost estimates obtained from the local contractor were independent of boiler type. Therefore, all new boiler types available were assumed to be approximately equal in the area of maintenance costs.

*Replacement Chiller Selection*: Data on available replacement chillers were obtained from typical manufacturers in order to select representative chillers for ECO evaluations. This data included performance characteristics, physical dimensions and cost figures. The criteria for selecting new chiller systems for the ECOs are described below.

1. Manufacturer. The facility maintenance personnel requested that York chillers be used in this study as they preferred them to other manufacturer's products. Therefore, most new chillers used for analysis in the ECOs were made by York. In areas 100 and the Quadrangle, McQuay chillers were selected for reasons mentioned in the following text.

2. Machine Type. The scope of work generally identified the specific types of chillers to be compared in each area. These were the centrifugal, centrifugal with variable speed drive, screw and gas-engine driven centrifugal. Therefore, all four of these chiller types were compared in each ECO to determine the most economically beneficial retrofit for each area. In areas 100 and the Quadrangle, where new central plants were under consideration, only packaged air-cooled type chillers were considered. This was done to minimize the implementation costs in these areas.

3. Drive configuration. The new machines selected for ECO analysis all had open drives on the compressors. This increases the first cost somewhat, but decreases the long term maintenance costs.

4. Refrigerant. Replacement chillers were to all use either R-123 or R-134 refrigerant, as per the scope of work. This requirement was met in the study.

5. Efficiency. The full and part load efficiencies for all machines selected for evaluation were used in the ECOs. The relative effects of these efficiency differences are illustrated in the

life cycle cost analysis of each machine. In Area 100, the most efficient type of air cooled packaged chiller found was the single-screw unit from McQuay. Therefore, this machine was used in the ECO evaluations.

6. First cost. The first cost data for all machines selected for evaluation were used in the ECOs. The relative effects of these cost differences are illustrated in the life cycle cost analysis of each machine.

7. Maintenance requirements and costs. All types of replacement chillers would require periodic cleaning of the heat exchanger surfaces, as well as optimization of the compressor systems and controls. Maintenance cost estimates obtained from the local contractor were independent of chiller type. Therefore, all new chiller types available were assumed to be approximately equal in the area of maintenance costs.

## C. Plan To Implement Projects

The analysis of all potential boiler and chiller ECOs at the facility has been completed and the grouping of the individual ECOs into projects has been determined. These projects were previously detailed in the Executive Summary. Below is an abbreviated plan for implementation of the recommended projects.

*Funding:* The forms DD-1391 and life cycle cost analysis summary sheets for the ECIP projects is provided on pages 24 through 40. These forms are to be submitted for project funding, along with the savings and cost estimates in Appendix B. Review the latest ECIP project documentation prior to submitting these forms.

*Programming:* An engineering design firm should be selected to produce construction contract drawings and specifications for all of the projects which are funded either through ECIP or other means. All of the savings calculations and cost estimates for the recommended ECOs in Appendix B should be supplied to the designers in order to inform them of the intent and projected budget for each ECO. The designers should use the equipment sizing criteria described in the ECOs as a guide only, and perform all calculations necessary to properly size all new equipment. These calculations should take into consideration all existing field conditions in the areas affected by the ECOs. It is recommended that existing auxiliary equipment be reused wherever possible to reduce the project first cost. The designer should field verify the condition of the existing equipment before specifying the disposition of the equipment. In the case of boiler retrofits, the designer should consider keeping some of the existing boilers in place for use a backup boilers. Where equipment is to be removed, the project specifications should include provisions for the possible salvage of the equipment. The facility Project Manager should ensure that all new central plant designs produced conform with the intent of each ECO, in order to realize the estimated savings. Prior to releasing construction bids, all construction drawings and specifications should be compared to the original ECOs to ensure compliance.

*Construction:* Once the project Contract Documents have been reviewed and approved, the facility Project Manager should release the Contract Documents for bid, using the normal construction procurement proceedings. Care should be taken to schedule all work to minimize the negative impact of the buildings served by the central plant equipment. Prior to construction, the facility should review all shop drawings and submittals to ensure compliance with original intent of each ECO.

| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 30 OCT 96 |
|---|---|---|

| 3. INSTALLATION AND LOCATION FORT SAM HOUSTON, SAN ANTONIO, TX. | 4. PROJECT TITLE ECIP |
|---|---|

| 5. PROGRAM ELEMENT | 6. CATAGORY CODE | 7. PROJECT NUMBER | 8. PROJECT COST ($000) 311.340 |
|---|---|---|---|

9. COST ESTIMATES

| ITEM | U/M | QUANTITY | UNIT COST | COST ($000) |
|---|---|---|---|---|
| High Efficiency, Modular Boiler Retrofit - ECO 0 | EA | 1 | 311.34 | 311.34 |
| ESTIMATED CONTRACT COST | | | | 278.405 |
| CONTINGENCY (0%) | | | | |
| SIOH | | | | 16.231 |
| DESIGN | | | | 16.704 |
| TOTAL REQUEST | | | | 311.340 |
| TOTAL REQUEST (ROUNDED) | | | | 311.000 |

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Remove the existing boilers located in Buildings 2200, 2244, 2247, 2248, 2270 and 2272. Also, remove the three 15 HP heating water (HW) distribution pumps in building 2265. The existing building pumps will be reutilized as secondary pumps. Install 3 modular high efficiency 2000 MBH HW boilers and three 7.5 HP primary HW pumps (172 GPM at 110 ft hd) in an addition to the central plant serving building 2200. Provide stainless steel flues and gas regulators for each boiler. HW to all buildings listed above will be provided through two separate loops of direct buried primary HW piping. One 3" loop will branch from the 6" main in the boiler plant and serve buildings 2244, 2247, 2248, 2250, 2270, 2272, and 2273. The second 5" loop will also extend from the 6" main in the boiler plant and tap into the existing HW loop serving buildings 2263, 2264, 2265, and 2266 just outside of the existing chiller plant serving these buildings. Approximately 800 ft. of 3", and 400 ft of 5" under ground piping will be require for these loop. Expand the existing central plant of building 2200 from the north wall and add an additional 750 sq ft. space. All buildings AHUs and fan/coil units will be retrofitted with new two way control valves. A HW temperature reset controller will be installed in the plant to improve HW system efficiency. All new controls gas and electrical services will be installed for the new equipment in Building 2200 to serve the new boilers and pumps.

| 1. COMPONENT<br>ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE<br>30 OCT 96 |
|---|---|---|

3. INSTALLATION AND LOCATION
FORT SAM HOUSTON, SAN ANTONIO, TX.

| 4. PROJECT TITLE<br>ECIP | 5. PROJECT NUMBER |
|---|---|

11. REQUIREMENT

This project is required to reduce the heating energy consumption in the distributed heating systems serving Area 2200 . The project provides new, more efficient primary heating systems, which will save heating energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these projects will result in the following:

| | | |
|---|---|---|
| Electrical Energy Savings | 7 | MMBTU/yr |
| Electrical Demand Savings | -171 | $/yr |
| Gas Energy Savings | 803 | MMBTU/yr |
| Total Energy Savings | 796 | MMBTU/yr |
| Total Cost Savings | 39,341 | $/yr |
| Total Investment | 311,340 | $ |
| Simple Payback | 7.9 | yrs |
| SIR | 1.92 | |

CURRENT SITUATION:

All heating equipment is located in different locations with each being remote to the other. All of these boilers appear to be in fair condition. However, the cost of maintaining these boilers is excessive. Therefore, it is recommended that three 2,000 MBH high efficiency gas fired high efficiency modular HW boilers be installed. These boilers are 86% efficient under full load conditions, and reach up to 98% efficiency under part load conditions. Also, they have the capability to be staged to maintain these part load efficiencies by remote boiler control. In retrofit projects such as this, the size of these boilers make it very economical and justifiable because of their ease of installation. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. Three primary pumps will also provide additional flexibility in staging. Existing outside temperature reset controller and necessary three way mixing valves on each secondary HW loop will b calibrated to enhance HW system efficiency. All AHUs and fan/coil units three way control valves will be converted to two way valves. Computer simulations of the four buildings served by these boilers determined that the current combined capacity of 13,322 MBH is much more than the amount required to adequately heat the buildings[1]. The existing boilers are therefore operating at an inefficient, low load condition most of the time. Also, because of the constant flow rate requirements of the boilers, excessive pumping energy is expended. By staging three new high efficiency modular boilers to operate only as needed, a substantial energy savings can be obtained. Also, a decrease in the combined boiler output capacity to 4,695 MBH is recommended to more closely match the heating load in the buildings and reduce the associated pumping energy consumption.

IMPACT IF NOT PROVIDED:

If this project is not provided, the heating energy and cost savings mentioned above will continue to be wasted. There will be no contribution to the energy reduction goals established at the facility.

DD FORM 1 DEC 76 1391

PAGE NO.

Life Cycle Cost Analysis Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-O
Analysis Date: 10/31/96 Economic Life: 20 years
Prepared by: JOHN CARTER

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $278,405 |
| B. SIOH | $16,231 |
| C. Design Cost | $16,704 |
| D. Total Cost (1A+1B+1C) | $311,340 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $311,340 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 7 | Mbtus | $44 | 15.08 | $663 |
| Elec. Deman | | | | | $0 | 14.88 | $0 |
| Natural Gas | $3.5 | /Mbtus | 803 | Mbtus | $2,778 | 18.58 | $51,622 |
| TOTAL | | | 810 | Mbtus | $2,822 | | $52,285 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $36,780 | Annual | 14.88 | $547,286 |
| ANNUAL TOTAL | $36,780 | | | $547,286 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $36,780 | | | $547,286 |

| | |
|---|---|
| 4. First Year Dollar Savings | $39,602 |
| 5. Simple Payback Period (Years) | 7.86 |
| 6. Total Net Discounted Savings | $599,572 |
| 7. Savings to Investment Ratio | 1.93 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 6.43% |

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. O Retrofit Individual Boilers AREA 2200

PROJECT NO: 03-185.60

BY : KOTHMANN, K

DATE: 10/31/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment AREA 2200

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| | | | | | | | | |
| REMOVE BOILER | 7 | EA | 90.0 | 28.91 | 18,213 | 780.00 | 5,460 | 23,673 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 3" | 800 | LF | 0.6 | 28.91 | 13,877 | 15.70 | 12,560 | 26,437 |
| 5" | 400 | LF | 1.04 | 28.91 | 12,027 | 29.50 | 11,800 | 23,827 |
| SCH 40 BKL STL PIPE W/ FTGS HNGRS & INSULATION | | | | | | | | |
| 2" | 100 | LF | 0.5 | 28.91 | 1,446 | 7.05 | 705 | 2,151 |
| 1-1/2" | 50 | LF | 0.4 | 28.91 | 578 | 5.05 | 253 | 831 |
| 1" | 50 | LF | 0.3 | 28.91 | 434 | 4.38 | 219 | 653 |
| 3/4" | 100 | LF | 0.3 | 28.91 | 954 | 2.75 | 275 | 1,229 |
| | | | | SUBTOTAL | 47,528 | | 31,272 | 78,800 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

512 MAIN STREET, SUITE 1500

FORT WORTH, TEXAS 76102-3922

(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.60 **DATE:** 10/31/96

**ECO NO. O** Retrofit Individual Boilers AREA 2200

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment AREA 2200

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 3" | 2 | EA | 7.0 | 28.91 | 405 | 475.00 | 950 | 1,355 |
| SECTIONALIZING VALVE AND BOX 5" | 2 | EA | 8.0 | 28.91 | 463 | 540.00 | 1,080 | 1,543 |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 150.0 | 20.00 | 3,000 | 2,000.00 | 2,000 | 5,000 |
| SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING HW PUMPS PER LOCATION | | | | | | | | |
| 2" | 1 | LOC | 9.6 | 28.91 | 278 | 639.00 | 639 | 917 |
| REPLACE 3-WAY CONTROL VALVES WITH 2-WAY | 71 | EA | 4.0 | 28.91 | 8,210 | 350.00 | 24,850 | 33,060 |
| | | | | SUBTOTAL | 12,355 | | 29,519 | 41,874 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX

PROJECT NO: 03-185.60

DATE: 10/31/96

ECO NO. O Retrofit Existing Boilers AREA 2200

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment AREA 2200

| ITEM DESCRIPTION SHEET 3 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| Install New Boiler AERCO # KC 2000 1830 MBH | 3 | EA | 100.00 | 28.91 | 8,673 | 18500.00 | 55,500 | 64,173 |
| Install New Pump 5 HP | 1 | EA | 10.00 | 28.91 | 289 | 1100.00 | 1,100 | 1,389 |
| Install New Pump 10 HP | 3 | EA | 15.00 | 28.91 | 1,301 | 2800.00 | 8,400 | 9,701 |
| pipe Assembly & valves Boiler | 3 | EA | 28.00 | 28.91 | 2,428 | 2400.00 | 7,200 | 9,628 |
| pipe Assembly & valves Pump | 4 | EA | 7.00 | 28.91 | 809 | 600.00 | 2,400 | 3,209 |
| Boiler Breaching | 3 | JOB | 30.00 | 28.91 | 2,602 | 2000.00 | 6,000 | 8,602 |
| Controls | 1 | JOB | 90.00 | 28.91 | 2,602 | 3900.00 | 3,900 | 6,502 |
| Electrical | 1 | JOB | 80.00 | 28.91 | 2,313 | 3500.00 | 3,500 | 5,813 |
| Test , Balance & Start-up | 1 | LS | 80.00 | 28.91 | 2,313 | | | 2,313 |
| | | | | SUBTOTAL | 23,330 | | 88,000 | 111,330 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. O Retrofit Existing Boilers AREA 2200

PROJECT NO: 03-185.60

BY : KOTHMANN, K

DATE: 10/31/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment AREA 2200

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 47,528 | | 31,272 | 78,800 |
| SUB TOTAL FROM SHEET 2 | | | | | 12,355 | | 29,519 | 41,874 |
| SUB TOTAL FROM SHEET 3 | | | | | 23,330 | | 88,000 | 111,330 |
| SUBTOTAL | | | | | 83,214 | | 148,791 | 232,004 |
| O & P @ 20% | | | | | 16,643 | | 29,758 | 46,401 |
| SUBTOTAL | | | | | 99,856 | | 178,549 | 278,405 |
| DESIGN @ 6% | | | | | | | | 16,704 |
| SUBTOTAL | | | | | | | | 295,109 |
| SIOH @ 5.5% | | | | | | | | 16,231 |
| TOTAL | | | | | | | | $311,340 |


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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. O Retrofit Existing BOILERS

PROJECT NO: 03-0185.6MA

DATE: 10/31/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment AREA 2200

ANNUAL COSTS

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER BOILER PER YEAR | | | | | | | | |
| EXISTING BOILER | -10. | EA | 100.0 | 30.00 | -30,000 | 1,800.00 | -18,000 | -48,000 |
| **NEW EQUIPMENT** | | | | | | | | |
| AERCO MODULAR HIGH EFFICIENCY HW BOILER | 3. | EA | 80.0 | 30.00 | 7,200 | 1,500.00 | 4,020 | 11,220 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -22,800 | | -13,980 | -36,780 |


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| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 30 OCT 96 |
|---|---|---|

| 3. INSTALLATION AND LOCATION | 4. PROJECT TITLE |
|---|---|
| FORT SAM HOUSTON, SAN ANTONIO, TX. | ECIP |

| 5. PROGRAM ELEMENT | 6. CATAGORY CODE | 7. PROJECT NUMBER | 8. PROJECT COST ($000) |
|---|---|---|---|
| | | | 945.482 |

9. COST ESTIMATES

| ITEM | U/M | QUANTITY | UNIT COST | COST ($000) |
|---|---|---|---|---|
| Central Plant Boiler Retrofit - ECO C | EA | 1 | 945.5 | 945.5 |
| ESTIMATED CONTRACT COST | | | | 845.463 |
| CONTINGENCY (0%) | | | | |
| SIOH | | | | 49.291 |
| DESIGN | | | | 50.728 |
| TOTAL REQUEST | | | | 945.482 |
| TOTAL REQUEST (ROUNDED) | | | | 945.000 |

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Phase 1- Install a new central heating plant near Building 250 where the two existing 726 MBH steam boilers are located. Removal of these boilers will leave enough space where 2 high efficiency modular HW boilers with 2000 MBH capacity each can be installed. Remove the existing boilers identified in Table 1 on Page B-14 of the energy audit report. The secondary pumps serving these boilers are to be reutilized. All existing localized chemical treatment systems for each building will be removed. All existing building HW pumps will be reutilized as secondary pumps, and they will be connected to the new primary loop. A new central chemical treatment system will be installed at Building 250. All new controls and electrical services to serve the new boilers and new primary pumps should be installed at Building 250.

Phase 2 - Remove the existing window units and split system furnaces and install fan/coil units in their place. Also install new secondary pumps to serve the FCUs. Buildings with window units and liquid cooled package units will be retrofitted with new air handling units and fan/coil units (FCUs) having HW coils. New secondary HW pumps will be installed to serve them. There will be a total of 56 window units and 3 split systems will be removed from the buildings identified in Table-2. on Page B-15 of the energy audit report. There will be 56 FCUs and 3 AHUs installed to replace them. Building 123 is served by five gas fired space heaters. They will be removed and replaced with six FCUs. Install 11 new secondary pumps to serve new FCUs and AHUs installed as part of this project.

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PAGE NO.

| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 30 OCT 96 |
|---|---|---|

3. INSTALLATION AND LOCATION
FORT SAM HOUSTON, SAN ANTONIO, TX.

| 4. PROJECT TITLE ECIP | 5. PROJECT NUMBER |
|---|---|

11. REQUIREMENT

This project is required to reduce the heating energy consumption in the distributed heating systems serving Area 100 . The project provides a new, more efficient centralized heating system, which will save heating energy and cost. All buildings included in this project will be active throughout the payback period. Installation of these projects will result in the following:

| | | |
|---|---|---|
| Electrical Energy Savings | 57 | MMBTU/yr |
| Electrical Demand Savings | 1295 | $/yr |
| Gas Energy Savings | 314 | MMBTU/yr |
| Total Energy Savings | 371 | MMBTU/yr |
| Total Cost Savings | 95,011 | $/yr |
| Total Investment | 945,482 | $ |
| Simple Payback | 9.95 | yrs |
| SIR | 1.48 | |

CURRENT SITUATION:

Phase 1 - All of the buildings to be renovated are historical buildings. Many of these buildings are served by HW boilers. Most of these boilers are natural draft fire tube boilers which are very inefficient. The efficiency of the boilers ranges from 60% to 70%. They generally appear to be in fair condition, but many older boilers show indications of rusting and leaks. Additionally, the cost of maintaining so many boilers is excessive and difficult for the maintenance staff. One reason is that these boilers are manufactured by several different manufacturers which require large PM and repair part inventory. It is recommended that a central boiler plant, consisting of two 2000 MBH high efficiency modular gas fired HW boilers will be installed. These boilers are 86% efficient under full load conditions, and reaching upwards to 98% efficiency under part load conditions. Moreover, these boilers have the capability to be staged to maintain these part load efficiencies by remote boiler control.

Phase II - Buildings indicated in Table-2 will be furnished with new FCUs and new secondary HW pumps. Their sizes are listed in Table 2. FCUs are selected over the AHUs because of the ease of construction and because of the historical significance of the area. Vertical convector type FCUs can be installed fairly easily in the place of the existing equipment without damaging the antiquity of the buildings. The DX coil split system will be removed from Buildings 127, 144 and 159. New horizontal ceiling mounted fan coils will replace the existing AHUs. Building 123 has five existing furnaces that will be replaced with six FCUs.

IMPACT IF NOT PROVIDED:

If this project is not provided, the heating energy and cost savings mentioned above will continue to be wasted. There will be no contribution to the energy reduction goals established at the facility.

Life Cycle Cost Analysis Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-C
Analysis Date: 10/31/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $845,463 |
| B. SIOH | $49,291 |
| C. Design Cost | $50,728 |
| D. Total Cost (1A+1B+1C) | $945,482 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $945,482 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 57 | Mbtus | $358 | 15.08 | $5,398 |
| Elec. Deman | | | | | $0 | 14.88 | $0 |
| Natural Gas | $4.4 | /Mbtus | 314 | Mbtus | $1,378 | 18.58 | $25,612 |
| TOTAL | | | 371 | Mbtus | $1,736 | | $31,010 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECU | $91,980 | Annual | 14.88 | $1,368,662 |
| ANNUAL TOTAL | $91,980 | | | $1,368,662 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $91,980 | | | $1,368,662 |

| | |
|---|---|
| 4. First Year Dollar Savings | $93,716 |
| 5. Simple Payback Period (Years) | 10.09 |
| 6. Total Net Discounted Savings | $1,399,672 |
| 7. Savings to Investment Ratio | 1.48 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 5.04% |

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6C | DATE: 10/31/96 |
| ECO NO. C Retrofit Existing Individual Boilers AREA 100 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 1 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| REMOVE BOILER UP TO 500 MBH | 19 | EA | 24.0 | 28.91 | 13,183 | 500.00 | 9,500 | 22,683 |
| REMOVE BOILER 500 MBH AND UP | 7 | EA | 48.0 | 28.91 | 9,714 | 780.00 | 5,460 | 15,174 |
| | | | | | | | | |
| | | | | | | | | |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 5" | 6,000 | LF | 0.9 | 28.91 | 156,114 | 27.50 | 165,000 | 321,114 |
| 2-1/2" | 120 | LF | 0.5 | 28.91 | 1,735 | 13.33 | 1,600 | 3,334 |
| 2" | 1,520 | LF | 0.4 | 28.91 | 17,577 | 13.55 | 20,596 | 38,173 |
| 1-1/2" | 540 | LF | 0.4 | 28.91 | 6,245 | 12.85 | 6,939 | 13,184 |
| 1" | 640 | LF | 0.35 | 28.91 | 6,476 | 11.55 | 7,392 | 13,868 |
| | | | | | | | | |
| | | | | SUBTOTAL | 211,043 | | 216,487 | 427,530 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. C** Retrofit Existing Individual Boilers AREA 100

**PROJECT NO:** 03-185.C6

**BY :** KOTHMANN, K

**DATE:** 10/31/96

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 5" | 8 | EA | 20.0 | 28.91 | 4,626 | 540.00 | 4,320 | 8,946 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 500.0 | 20.00 | 10,000 | 9,000.00 | 9,000 | 19,000 |
| SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING HW PUMPS PER LOCATION | | | | | | | | |
| 2-1/2" | 1 | LOC | 9.6 | 28.91 | 278 | 639.00 | 639 | 917 |
| 1-1/2" TO 1" | 20 | LOC | 8.0 | 28.91 | 4,626 | 600.00 | 12,000 | 16,626 |
| ALL AIR SIDE EQUIPMENT INCLUDED IN ECO B | | | | | | | | |
| ADD PIPING ASSEMBLY &HOT WTR COIL | | | | | | | | |
| VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY | 6 | EA | 10.0 | 28.91 | 1,735 | 1,200.00 | 7,200 | 8,935 |
| AHU W/ HW COIL 2-PIPE 2000 CFM | 2 | EA | 14.5 | 28.91 | 838 | 1,100.00 | 2,200 | 3,038 |
| | | | | SUBTOTAL | 22,102 | | 35,359 | 57,461 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FT SAM HOUSTON , SAN ANTONIO TEX | PROJECT NO: 03-185.6C | DATE: 10/31/96 |
| ECO NO. C Retrofit Individual Boilers AREA 100 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install New Boiler AERCO # KC 2000 1830 MBH | 2 | EA | 100.00 | 28.91 | 5,782 | 18500.00 | 37,000 | 42,782 |
| Install New Pump 10 HP | 2 | EA | 15.00 | 28.91 | 867 | 2800.00 | 5,600 | 6,467 |
| pipe Assembly & valves Boiler | 2 | EA | 28.00 | 28.91 | 1,619 | 2400.00 | 4,800 | 6,419 |
| pipe Assembly & valves Pump | 2 | EA | 12.00 | 28.91 | 694 | 1350.00 | 2,700 | 3,394 |
| Boiler Breaching | 1 | JOB | 50.00 | 28.91 | 1,446 | 2500.00 | 2,500 | 3,946 |
| Controls | 1 | JOB | 160.00 | 28.91 | 4,626 | 6900.00 | 6,900 | 11,526 |
| Electrical | 1 | JOB | 100.00 | 28.91 | 2,891 | 5900.00 | 5,900 | 8,791 |
| Chemical Shot Feed | 1 | JOB | 16.00 | 28.91 | 463 | 1500.00 | 1,500 | 1,963 |
| Test , Balance & Start-up | 1 | LS | 160.00 | 28.91 | 4,626 | | | 4,626 |
| | | | | SUBTOTAL | 23,012 | | 66,900 | 89,912 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6C | | DATE: 10/31/96 |
| ECO NO. C Retrofit Existing Individual Boilers AREA 100 | BY : KOTHMANN, K | | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE TWO 52497 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE GAS FIRED SPACE HTR | 5 | EA | 4.0 | 22.00 | 440 | 10.00 | 50 | 490 |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 1" | 1,100 | LF | 0.3 | 28.91 | 10,176 | 10.65 | 11,715 | 21,891 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 250 | LF | 0.5 | 28.91 | 3,614 | 7.05 | 1,763 | 5,376 |
| 1-1/2" | 525 | LF | 0.4 | 28.91 | 6,071 | 5.05 | 2,651 | 8,722 |
| 1" | 1,000 | LF | 0.3 | 28.91 | 8,673 | 4.38 | 4,380 | 13,053 |
| 3/4" | 2,100 | LF | 0.3 | 28.91 | 18,213 | 2.75 | 5,775 | 23,988 |
| | | | | SUBTOTAL | 47,187 | | 26,334 | 73,521 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. C** Retrofit Existing Individual Boilers AREA 100

**PROJECT NO:** 03-185.6C | **DATE:** 10/31/96

**BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
PHASE TWO 52497 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , HW ENTRY PIPING ASSEMBLY 1" | 11 | LOC | 14.0 | 28.91 | 4,452 | 1,300.00 | 14,300 | 18,752 |
| AND NEW HOT WTR PUMPS COST PER LOCATION | | | | | | | | |
| ALL AIR SIDE EQUIPMENT INCLUDED IN ECO B | | | | | | | | |
| ADD PIPING ASSEMBLY & HOT WTR COIL | | | | | | | | |
| 3/4" CONTROL VALVE 2- WAY | 3 | EA | 4.0 | 28.91 | 347 | 595.00 | 1,785 | 2,132 |
| 1/2" " " 3-WAY | 7 | EA | 4.0 | 28.91 | 809 | 475.00 | 3,325 | 4,134 |
| 1/2" " " 2 - WAY | 55 | EA | 4.0 | 28.91 | 6,360 | 450.00 | 24,750 | 31,110 |
| SUB TOTAL FROM SHEET 1 | | | | | 211,043 | | 216,487 | 427,530 |
| SUB TOTAL FROM SHEET 2 | | | | | 22,102 | | 35,359 | 57,461 |
| SUB TOTAL FROM SHEET 3 | | | | | 23,012 | | 66,900 | 89,912 |
| SUB TOTAL FROM SHEET 4 | | | | | 47,187 | | 26,334 | 73,521 |
| | | | | SUBTOTAL | 315,313 | | 389,239 | 704,553 |
| | | | | O & P @ 20% | 63,063 | | 77,848 | 140,911 |
| | | | | SUBTOTAL | 378,376 | | 467,087 | 845,463 |
| | | | | DESIGN @ 6% | | | | 50,728 |
| | | | | SUBTOTAL | | | | 896,191 |
| | | | | SIOH @ 5.5% | | | | 49,291 |
| | | | | TOTAL | | | | $945,481 |

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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.6MA | DATE: 10/31/96

ECO NO. C Retrofit Existing BOILERS | BY : KOTHMANN, K | CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 100

ANNUAL COSTS

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER BOILER PER YEAR | | | | | | | | |
| EXISTING BOILER | -21. | EA | 100.0 | 30.00 | -63,000 | 1,800.00 | -37,800 | -100,800 |
| **NEW EQUIPMENT** | | | | | | | | |
| AERCO MODULAR HIGH EFFICIENCY HW BOILER | 2. | EA | 80.0 | 30.00 | 4,800 | 1,500.00 | 4,020 | 8,820 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -58,200 | | -33,780 | -91,980 |

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APPENDIX A
ENERGY COST ANALYSIS

TABLE OF CONTENTS

APPENDIX A
ENERGY COST ANALYSIS

A. Electrical Energy Cost Analysis

*Electrical Rate Schedule:* The post purchases it's electrical power from the City Public Service (CPS) of San Antonio, and is billed under the Super Large Power (SLP) rate. Service is provided through a single substation on the post, owned by the Army. The SLP rate has been in effect since January of 1994, and was created by the utility company to lower military base charges, thereby helping to avoid base closures. This rate has resulted in substantial cost decreases, even though the electrical usage on the post has increased. The monthly SLP billing rate components are as follows:

| | | |
|---|---|---|
| Service Availability Charge: | \$1,000 | |
| Energy Charge: | \$0.024/KWH | |
| Demand Charge: | \$10.00/KW billing demand<br>\$7.50/KW billing demand | (June through September)<br>(October through May) |
| where: | billing demand is the highest 15 minute metered KW demand during the month, or 5000 KW, or 80% of highest billing demand from previous June through September (applicable only from October through May), whichever is greatest | |
| Fuel Cost Adjustment: | calculated monthly, difference between actual fuel cost and \$0.016/KWH (average variance from base year data is -\$0.002566/KWH) | |

*Avoided Costs:* In order to convert electric demand and energy savings into dollar savings, the avoided costs of demand and energy are determined. These are the marginal cost savings to be realized by the post, per unit of demand or energy saved. Using the above billing components, the *Avoided Cost of Demand* ($C_{SD}$ & $C_{WD}$) and the *Avoided Cost of Energy* ($C_E$) are determined as follows:

$$C_{SD} = \frac{\$10.00}{KW} \quad \text{(June through September)}$$

$$C_{WD} = \frac{\$7.50}{KW} \quad \text{(October through May)}$$

$$C_E = ( E + F ) \; x \; \frac{KWH}{3413 \; BTU} \; x \; \frac{1{,}000{,}000 \; BTU}{MMBTU} \qquad \frac{\$}{MMBTU}$$

where,

E = energy charge = \$0.024/KWH
F = fuel cost factor = -\$0.002566/KWH

$$C_E = (0.024 - 0.002566)\ x\ \frac{1{,}000{,}000}{3413} = \frac{\$6.28}{MMBTU}$$

*Rebate Program:* The City Public Service of San Antonio currently offers no cash incentives for energy conservation retrofits.

B. Natural Gas Energy Cost Analysis

*Gas Rate Schedules:* FSH is currently supplied natural gas by CPS through many meters distributed throughout the post. There are three primary rate structures that the CPS uses for billing at Fort Sam Houston and they are: rates G (04), B (10), and LVG (18). In general, the rates are tiered according to the capacity of the meter being served as follows:

| Rate | Capacity (MCF) |
|---|---|
| G (04) | 0-57 |
| B (10) | 57.1-500 |
| LVG (18) | 500.1& Above |

For the purposes of this study, CPS currently bills all of the buildings included in this study on the first two (2) rates (G & B).

All of the buildings in the area 100 and bldgs. 1001, 1396, 1398, 2200, 2244, 2247, 2248, 2250, 2270, 2272, and 2273 have individual gas meters and are billed under the General Service Gas (G) rate # 04. The monthly G billing rate components are as follows:

| | |
|---|---|
| Service Availability Charge: | \$3.85 |
| Energy Charge: | \$4.38/MCF |
| Fuel Adjustment: | calculated monthly, difference between actual gas cost and \$2.20/MCF (average variance from base year data is \$0.0142/MCF) |

The remainder of the buildings in this study are billed under a third rate (B) # 10 which is used for heating and cooling plants that do not fall under the LVG rate. The monthly B billing rate components are as follows:

| | |
|---|---|
| Service Availability Charge: | \$28.00 |
| Energy Charge: | \$3.94/MCF for first 600 MCF<br>\$3.45/MCF for all additional MCF |
| Fuel Adjustment: | calculated monthly, difference between actual gas cost and \$2.20/MCF (average variance from base year data is \$0.0142/MCF) |

*Avoided Costs:* In order to convert gas energy savings or penalties into cost savings or penalties, the *Avoided Cost of Gas* ($C_G$) is determined for each area as described above as follows:

*Area 100,*

$$C_G = ( E + F ) \; x \; \frac{1 \; MCF}{MMBTU} \qquad \frac{\$}{MMBTU}$$

where,

E = energy charge = \$4.38 MCF
F = fuel adjustment = \$0.0142 per MCF (average from base year data)

$$C_G = ( 4.38 + 0.0142 ) = 4.39 \; \frac{\$}{MMBTU}$$

*Area 500,*

$$C_G = ( E + F ) \; x \; \frac{1 \; MCF}{MMBTU} \qquad \frac{\$}{MMBTU}$$

where,

E = energy charge = \$3.45 MCF
F = fuel adjustment = \$0.0142 per MCF (average from base year data)

$$C_G = ( 3.45 + 0.0142 ) = 3.46 \; \frac{\$}{MMBTU}$$

Note: The avoided cost for this area was calculated using the upper tier of the rate structure (consumption > 600 MCF) because it was determined from actual bills that the savings will occur in the upper tier.

*Area 1000,*

$$C_G = ( E + F ) \; x \; \frac{1 \; MCF}{MMBTU} \qquad \frac{\$}{MMBTU}$$

where,

E = energy charge = \$3.45 MCF
F = fuel adjustment = \$0.0142 per MCF (average from base year data)

$$C_G = ( 3.45 + 0.0142 ) = 3.46 \; \frac{\$}{MMBTU}$$

Note: The avoided cost for this area was calculated using the upper tier of

the rate structure (consumption > 600 MCF) because it was determined from actual bills that most of the savings will occur in the upper tier. There will be some savings associated with Rate G, but it is negligible compared to the total consumption savings.

*Area 1300,*

$$C_G = ( E + F ) \; x \; \frac{1 \; MCF}{MMBTU} \qquad \frac{\$}{MMBTU}$$

where,

E = energy charge = $3.45 MCF
F = fuel adjustment = $0.0142 per MCF (average from base year data)

$$C_G = ( 3.45 + 0.0142 ) = 3.46 \; \frac{\$}{MMBTU}$$

Note: The avoided cost for this area was calculated using the upper tier of the rate structure (consumption > 600 MCF) because it was determined from actual bills that most of the savings will occur in the upper tier. There will be some savings associated with Rate G, but it is negligible compared to the total consumption savings.

*Area 2200,*

$$C_G = ( E + F ) \; x \; \frac{1 \; MCF}{MMBTU} \qquad \frac{\$}{MMBTU}$$

where,

E = energy charge = $3.45 MCF
F = fuel adjustment = $0.0142 per MCF (average from base year data)

$$C_G = ( 3.45 + 0.0142 ) = 3.46 \; \frac{\$}{MMBTU}$$

Note: The avoided cost for this area was calculated using the upper tier of the rate structure (consumption > 600 MCF) because it was determined from actual bills that most of the savings will occur in the upper tier. There will be some savings associated with Rate G, but it is negligible compared to the total consumption savings.

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | O |
| DATE: | 3/1/96 |
| ECO TITLE: | Replace Existing Central Boilers With High Efficiency Modular Boilers |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 2200, Building 2265 (serving 2200, 2244, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272, and 2273) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 7 | MMBTU/yr |
| Electrical Demand Savings | -171 | $/yr |
| Gas Energy Savings | 803 | MMBTU/yr |
| Total Energy Savings | 796 | MMBTU/yr |
| Total Cost Savings | 39,431 | $/yr |
| Total Investment | 311,340 | $ |
| Simple Payback | 7.9 | yrs |
| SIR | 1.92 | |

B. ECO Description:

Remove the existing boilers as listed below in Figure-1. Also, remove the three 15 HP heating water (HW) distribution pumps in building 2265. The existing building pumps will be reutilized as secondary pumps. Install 3 modular high efficiency 2000 MBH HW boilers and three 7.5 HP primary HW pumps (172 GPM at 110 ft hd) in an addition to the central plant serving building 2200. Along with the boilers, provide stainless steel flues and gas regulators for each boiler. HW to all buildings listed in Table 1 will be provided through two separate loops of direct buried primary HW piping. One 3" loop will branch from the 6" main in the boiler plant and serve buildings 2244, 2247, 2248, 2250, 2270, 2272, and 2273. The second 5" loop will also extend from the 6" main in the boiler plant and tap into the existing HW loop serving buildings 2263, 2264, 2265, and 2266 just outside of the existing chiller plant serving these buildings. Approximately 800 ft. of 3", and 400 ft of 5" under ground piping will be required for these loop. Expand the existing central plant of building 2200 from the north wall and add an additional 750 sq ft. space. All buildings AHUs and fan/coil units will be retrofitted with new two way control valves. A HW temperature reset controller will be installed in the plant to improve HW system efficiency. All new controls gas and electrical services will be installed for the new equipment in Building 2200 to serve the new boilers and pumps. Specific requirements in these areas should be determined by the design engineer responsible for this project. The boilers and pumps should be sequenced to operate only as needed to maintain the supply water temperature set-point of approximately 180°F. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing boilers and pumps, and installation of the new boilers, pumps, associated wiring and controls.

**Figure 1**

| Bldg. # | Quantity | Description | Size MBH | Flow GPM | Estimated Pipe Size inches | Extimated Pipe Length Feet |
|---|---|---|---|---|---|---|
| 2200 | 1 | HW boiler | 831.7 | 68 | 1.5 | 70 |
| 2244 | 1 | HW boiler | 112.2 | 15 | 1 | 70 |
| 2247 | 1 | HW boiler | 128.5 | 15 | 1 | 70 |
| 2248 | 1 | HW boiler | 679 | 60 | 1.5 | 70 |
| 2270 | 2 | HW boiler | 550 | 110 | 2 | 70 |
| 2272 | 1 | HW boiler | 388 | 120 | 2 | 70 |
| Total | 7 | HW boiler | 3239.4 | 388 | N/A | N/A |

C. Discussion:

All heating equipment is located in different locations with each being remote to the other. All of these boilers appear to be in fair condition. However, the cost of maintaining these boilers is excessive. Therefore, it is recommended that three 2,000 MBH high efficiency gas fired high efficiency modular HW boilers be installed. These boilers are 86% efficient under full load conditions, and reach up to 98% efficiency under part load conditions. Also, they have the capability to be staged to maintain these part load efficiencies by remote boiler control. In retrofit projects such as this, the size of these boilers make it very economical and justifiable because of their ease of installation. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. Three primary pumps will also provide additional flexibility in staging. Existing outside temperature reset controller and necessary three way mixing valves on each secondary HW loop will be calibrated to enhance HW system efficiency. All AHUs and fan/coil units three way control valves will be converted to two way valves. The central plant serving Building 2200 is centrally located to serve the rest of the buildings in this area. Therefore, the existing boiler room at Building 2200 will be expanded to house the new equipment. Computer simulations of the four buildings served by these boilers determined that the current combined capacity of 13,322 MBH is much more than the amount required to adequately heat the buildings[1]. The existing boilers are therefore operating at an inefficient, low load condition most of the time. Also, because of the constant flow rate requirements of the boilers, excessive pumping energy is expended. By staging three new high efficiency modular boilers to operate only as needed, a substantial energy savings can be obtained. Also, a decrease in the combined boiler output capacity to 4,695 MBH is recommended to more closely match the heating load in the buildings and reduce the associated pumping energy consumption.

D. Savings Calculations:

The monthly peak demand and energy consumptions of the existing and proposed boilers and HW pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3].

Full and part load performance data from Aerco International were used in the computer simulations of the new boiler energy usages[4]. An equipment list with specific data on the new boilers and pumps used in the computer simulation is shown on page B-4.

Once the computer simulations of the existing and new boiler systems were completed, the total annual demand cost and energy consumption of the new systems were compared with that of the existing systems to determine the annual savings[5]. These savings calculations are shown on pages B-5 through B-6. The demand and energy savings values were used in the life cycle cost analysis for this ECO.

E. Cost Estimates

The total installation costs for this ECO were estimated on pages B-7 through B-10. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page B-11. The data from the life cycle cost analysis were included in the summary on page B-1.

REFERENCES

1. See Appendix H for Area 2200 heating system load profile.

2. See Appendix H for computer model input assumptions and data, and energy consumption output data.

3. See Appendix G for building field data and existing HVAC system data.

4. See Appendix F for manufacturer's equipment performance data from Aerco International.

5. See Appendix A for utility cost analysis data, used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-O, FORT SAM HOUSTON, AREA 2200

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Hot Water Boiler | 3 | Aerco #KC-2000 GWB<br>natural draft, watertube<br>1830 MBH output | Area 2200 | New | 2,000 MBH |
| Heating Water Pump | 3 | Bell and Gossett<br>172 gpm, 150 ft<br>15 HP | Area 2200 | New | 11.20 KW |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| ITEM | ECO O - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| HW boiler (2263) blr-1 | | | | | | | | | | | | | | 1,568 |
| HW pump (2263) blr-1 | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48653.0 | |
| HW controls (2263) blr-1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW pump (2263) blr-1 | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| HW boiler (2263) blr-2 | | | | | | | | | | | | | | 28 |
| HW pump (2263) blr-2 | 11.2 | 11.2 | | | | | | | | | | 11.2 | 1,154 | |
| HW controls (2263) blr-2 | 0.1 | 0.1 | | | | | | | | | | 0.1 | 13 | |
| HW pump (2263) blr-2 | 0.6 | 0.6 | | | | | | | | | | 0.6 | 70 | |
| HW boiler (2263) blr-3 | | | | | | | | | | | | | | |
| HW pump (2263) blr-3 | | | | | | | | | | | | | | |
| HW controls (2263) blr-3 | | | | | | | | | | | | | | |
| HW pump (2263) blr-3 | 0.6 | 0.6 | | | | | | | | | | 0.6 | 12 | |
| HW boiler (2200) | | | | | | | | | | | | | | 727 |
| HW controls (2200) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 543 | |
| HW boiler (2244) | | | | | | | | | | | | | | |
| HW controls (2244) | | | | | | | | | | | | | | |
| Steam boiler (2247) | | | | | | | | | | | | | | 158 |
| Steam boiler controls (2247) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW boiler (2248,50) | | | | | | | | | | | | | | 144 |
| HW controls (2248,50) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 313 | |
| HW boiler (2270) blr-1 | | | | | | | | | | | | | | 1,396 |
| HW controls (2270) blr-1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW boiler (2270) blr-2 | | | | | | | | | | | | | | 3 |
| HW controls (2270) blr-2 | | 0.1 | | | | | | | | | | 0.1 | 11 | |
| HW boiler (2272,73) | | | | | | | | | | | | | | 112 |
| HW controls (2272,73) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 317 | |
| | | | | | | | | | | | | | | |
| Totals | 24.9 | 25.0 | 12.4 | 12.4 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 12.4 | 25.0 | 55,148 | 4,134 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 187 | 188 | 93 | 93 | 1 | 1 | 1 | 1 | 1 | 1 | 93 | 188 | | |

| | | | |
|---|---|---|---|
| Total Demand | 846 | $/yr | |
| Total Energy | 188 | MMBTU/yr | (electric) |
| Total Energy | 4,134 | MMBTU/yr | (gas) |

## 2200 AREA

| ITEM | ECO-O: INSTALL HIGH EFFICIENCY MODULAR BOILERS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| High % modular boiler | | | | | | | | | | | | | | 2,958 |
| HW pump | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48,653 | |
| HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| High % modular boiler | | | | | | | | | | | | | | 365 |
| HW pump | 11.2 | 11.2 | | | | | | | | | | 11.2 | 3,248 | |
| HW controls | 0.1 | 0.1 | | | | | | | | | | 0.1 | 36 | |
| High % modular boiler | | | | | | | | | | | | | | 8 |
| HW pump | 11.2 | 11.2 | | | | | | | | | | 11.2 | 605 | |
| HW controls | 0.1 | 0.1 | | | | | | | | | | 0.1 | 7 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 33.9 | 33.9 | 11.3 | 11.3 | | | | | | | 11.3 | 33.9 | 53,092 | 3,331 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 254 | 254 | 85 | 85 | | | | | | | 85 | 254 | | |

| | | | |
|---|---|---|---|
| Total Demand | 1,017 | $/yr | |
| Demand Savings | -171 | $/yr | |
| Energy Savings | 7 | MMBTU/yr | (electric) |
| Energy Savings | 803 | MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. O Retrofit Individual Boilers AREA 2200

PROJECT NO: 03-185.60

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment AREA 2200

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| | | | | | | | | |
| REMOVE BOILER | 7 | EA | 90.0 | 28.91 | 18,213 | 780.00 | 5,460 | 23,673 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 3" | 800 | LF | 0.6 | 28.91 | 13,877 | 15.70 | 12,560 | 26,437 |
| 5" | 400 | LF | 1.04 | 28.91 | 12,027 | 29.50 | 11,800 | 23,827 |
| SCH 40 BKL STL PIPE W/ FTGS HNGRS & INSULATION | | | | | | | | |
| 2" | 100 | LF | 0.5 | 28.91 | 1,446 | 7.05 | 705 | 2,151 |
| 1-1/2" | 50 | LF | 0.4 | 28.91 | 578 | 5.05 | 253 | 831 |
| 1" | 50 | LF | 0.3 | 28.91 | 434 | 4.38 | 219 | 653 |
| 3/4" | 100 | LF | 0.3 | 28.91 | 954 | 2.75 | 275 | 1,229 |
| | | | | SUBTOTAL | 47,528 | | 31,272 | 78,800 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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ENGINEERS / ARCHITECTS

512 MAIN STREET, SUITE 1500

FORT WORTH, TEXAS 76102-3922

(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. O Retrofit Individual Boilers AREA 2200

PROJECT NO: 03-185.60

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment AREA 2200

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 3" | 2 | EA | 7.0 | 28.91 | 405 | 475.00 | 950 | 1,355 |
| SECTIONALIZING VALVE AND BOX 5" | 2 | EA | 8.0 | 28.91 | 463 | 540.00 | 1,080 | 1,543 |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 150.0 | 20.00 | 3,000 | 2,000.00 | 2,000 | 5,000 |
| SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING HW PUMPS PER LOCATION | | | | | | | | |
| 2" | 1 | LOC | 9.6 | 28.91 | 278 | 639.00 | 639 | 917 |
| REPLACE 3-WAY CONTROL VALVES WITH 2-WAY | 71 | EA | 4.0 | 28.91 | 8,210 | 350.00 | 24,850 | 33,060 |
| SUBTOTAL | | | | | 12,355 | | 29,519 | 41,874 |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| TOTAL | | | | | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FT SAM HOUSTON , SAN ANTONIO TEX | **PROJECT NO:** 03-185.60 | **DATE:** 3/2/96

**ECO NO. O** Retrofit Existing Boilers AREA 2200 | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment AREA 2200

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install New Boiler AERCO # KC 2000 1830 MBH | 3 | EA | 100.00 | 28.91 | 8,673 | 18500.00 | 55,500 | 64,173 |
| Install New Pump 5 HP | 1 | EA | 10.00 | 28.91 | 289 | 1100.00 | 1,100 | 1,389 |
| Install New Pump 10 HP | 3 | EA | 15.00 | 28.91 | 1,301 | 2800.00 | 8,400 | 9,701 |
| pipe Assembly & valves Boiler | 3 | EA | 28.00 | 28.91 | 2,428 | 2400.00 | 7,200 | 9,628 |
| pipe Assembly & valves Pump | 4 | EA | 7.00 | 28.91 | 809 | 600.00 | 2,400 | 3,209 |
| Boiler Breaching | 3 | JOB | 30.00 | 28.91 | 2,602 | 2000.00 | 6,000 | 8,602 |
| Controls | 1 | JOB | 90.00 | 28.91 | 2,602 | 3900.00 | 3,900 | 6,502 |
| Electrical | 1 | JOB | 80.00 | 28.91 | 2,313 | 3500.00 | 3,500 | 5,813 |
| Test , Balance & Start-up | 1 | LS | 80.00 | 28.91 | 2,313 | | | 2,313 |
| | | | | SUBTOTAL | 23,330 | | 88,000 | 111,330 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. O Retrofit Existing Boilers AREA 2200

PROJECT NO: 03-185.60

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment AREA 2200

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 47,528 | | 31,272 | 78,800 |
| SUB TOTAL FROM SHEET 2 | | | | | 12,355 | | 29,519 | 41,874 |
| SUB TOTAL FROM SHEET 3 | | | | | 23,330 | | 88,000 | 111,330 |
| SUBTOTAL | | | | | 83,214 | | 148,791 | 232,004 |
| O & P @ 20% | | | | | 16,643 | | 29,758 | 46,401 |
| SUBTOTAL | | | | | 99,856 | | 178,549 | 278,405 |
| DESIGN @ 6% | | | | | | | | 16,704 |
| SUBTOTAL | | | | | | | | 295,109 |
| SIOH @ 5.5% | | | | | | | | 16,231 |
| TOTAL | | | | | | | | $311,340 |


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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.6MA | DATE: 3/2/96 |
| ECO NO. O Retrofit Existing BOILERS | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment AREA 2200

ANNUAL COSTS

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER BOILER PER YEAR | | | | | | | | |
| EXISTING BOILER | -10. | EA | 100.0 | 30.00 | -30,000 | 1,800.00 | -18,000 | -48,000 |
| **NEW EQUIPMENT** | | | | | | | | |
| AERCO MODULAR HIGH EFFICIENCY HW BOILER | 3. | EA | 80.0 | 30.00 | 7,200 | 1,500.00 | 4,020 | 11,220 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -22,800 | | -13,980 | -36,780 |


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Life Cycle Cost Analysis    Study: FSH-3.LC
Energy Conservation Investment Program (ECIP)    LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS    Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-O
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: JOHN CARTER

## ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | $278,405 |
| B. | SIOH | $16,231 |
| C. | Design Cost | $16,704 |
| D. | Total Cost (1A+1B+1C) | $311,340 |
| E. | Salvage Value of Existing Equip. | $0 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $311,340 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 7 | Mbtus | $44 | 15.08 | $663 |
| Elec. Deman | | | | | -$171 | 14.88 | -$2,544 |
| Natural Gas | $3.5 | /Mbtus | 803 | Mbtus | $2,778 | 18.58 | $51,622 |
| TOTAL | | | 810 | Mbtus | $2,651 | | $49,741 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $36,780 | Annual | 14.88 | $547,286 |
| ANNUAL TOTAL | $36,780 | | | $547,286 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $36,780 | | | $547,286 |

| | | |
|---|---|---|
| 4. | First Year Dollar Savings | $39,431 |
| 5. | Simple Payback Period (Years) | 7.9 |
| 6. | Total Net Discounted Savings | $597,027 |
| 7. | Savings to Investment Ratio<br>If < 1, Project does not qualify | 1.92 |
| 8. | Adjusted Internal Rate of Return | 6.41% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | C |
| DATE: | 3/1/96 |
| ECO TITLE: | Retrofit Existing Individual Boilers With Central Boiler Plant |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 100 (serving buildings 122, 123, 124, 125, 126, 127, 128, 129, 131,133, 134, 135, 140, 141,142, 143, 144,145, 146, 147, 149, 151, 152, 154, 155, 156, 157, 158, 159, 197, 198, 199, 250, 260, and 261) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 57 | MMBTU/yr |
| Electrical Demand Savings | 1295 | $/yr |
| Gas Energy Savings | 314 | MMBTU/yr |
| Total Energy Savings | 371 | MMBTU/yr |
| Total Cost Savings | 95,011 | $/yr |
| Total Investment | 945,482 | $ |
| Simple Payback | 9.95 | yrs |
| SIR | 1.48 | |

B. ECO Description:

Phase 1- Install a new central heating plant near Building 250 where the two existing 726 MBH steam boilers are located. Removal of these boilers will leave enough space where 2 high efficiency modular HW boilers with 2000 MBH capacity each can be installed. New stainless steel flues will be installed to remove combustion gases from the boilers. Two 10 HP primary HW pumps selected at 172 GPM and 120 ft. Head will be installed to serve the buildings listed in Table 1. HW will be provide through a direct buried 5" primary HW supply and return piping loop from this plant. This primary HW loop will run parallel with the new primary CHW lines and split behind Building 155. The first branch will be extended up to Building 198, and the second branch be will be extended to Building 261. The estimated length of the distribution loop will be 6000 ft. Remove the boilers as listed in Table-1. The secondary pumps serving these boilers are to be reutilized and their approximate pipe sizes and estimated lengths are listed in Table-1. All existing localized chemical treatment systems for each building will be removed. All existing building HW pumps will be reutilized as secondary pumps, and they will be connected to the new primary loop. A new central chemical treatment system will be installed at Building 250. All new controls and electrical services to serve the new boilers and new primary pumps should be installed at Building 250. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new boilers and associated wiring and controls.

Table-1

| Bldg. # | Quantity | Description | Size MBH | Flow GPM | Estimated Pipe Size inches | Extimated Pipe Length Feet |
|---|---|---|---|---|---|---|
| 122 | 1 | HW Boiler | 618 | 62 | 1.5 | 60 |
| 126 | 1 | HW Boiler | 587 | 59 | 1.5 | 60 |
| 128 | 1 | HW Boiler | 109 | 11 | 1 | 70 |
| 129 | 1 | HW Boiler | 129 | 13 | 1 | 60 |
| 131 | 1 | HW Boiler | 201 | 21 | 1 | 60 |
| 133 | 1 | HW Boiler | 109 | 11 | 1 | 70 |
| 134 | 1 | HW Boiler | 596 | 60 | 1.5 | 60 |
| 142 | 1 | HW Boiler | 327 | 33 | 1.25 | 60 |
| 143 | 1 | HW Boiler | 596 | 60 | 1.5 | 60 |
| 144 | 1 | HW Boiler | 596 | 60 | 1.5 | 60 |
| 146 | 1 | HW Boiler | 596 | 60 | 1.5 | 60 |
| 147 | 1 | HW Boiler | 596 | 60 | 1.5 | 75 |
| 149 | 1 | HW Boiler | 596 | 60 | 1.5 | 60 |
| 155 | 1 | HW Boiler | 47.17 | 48 | 1.5 | 60 |
| 156 | 1 | HW Boiler | 125.1 | 13 | 1 | 60 |
| 197 | 1 | HW Boiler | 1400 | 140 | 2.5 | 60 |
| 198 | 1 | HW Boiler | 327 | 33 | 1 | 70 |
| 199 | 1 | HW Boiler | 145 | 15 | 1 | 70 |
| 250 | 2 | Steam Boilers | 726 | 73 | 1.5 | 80 |
| 260 | 1 | HW Boiler | 47.4 | 10 | 1 | 80 |
| Total | 21 | HW Equipment | 9200 | 975 | N/A | N/A |

Phase 2 - Remove the existing window units and split system furnaces as shown in Table-2 and install fan/coil units in their place. Also install new secondary pumps to serve the FCUs. Buildings with window units and liquid cooled package units will be retrofitted with new air handling units and fan/coil units (FCUs) having HW coils. New secondary HW pumps will be installed to serve them. There will be a total of 56 window units and 3 split systems will be removed from the buildings listed in Table-2. There will be 56 FCUs and 3 AHUs installed to replace them. Building 123 is served by five gas fired space heaters. They will be removed and replaced with six FCUs. Approximately 250 ft. of 2”, 525 ft. of 1.5”, 1000 ft. of 1.0” and 2100 ft. of 0.75” piping will be required to feed HW to these new FCUs and AHUs. Approximately 55 each ½” two way, 7 each ½” three way, 3 each 3/4” two way control valves and 62 electric thermostats will be required. Install 11 new secondary pumps to serve new FCUs and AHUs as indicated in Table-2.

Table-2

| Bldg. # | Quantity | Description | Size MBH | Flow GPM | Estimated Secondary Pump Size GPM | HP |
|---|---|---|---|---|---|---|
| 123 | 5 | space heaters | 700 | 70 | 70 | 1.5 |
| 127 | 1 | furnace | 33 | 4 | 4 | 0.125 |
| 141 | 2 | window units | 34.6 | 4 | 4 | 0.125 |
| 144 | 1 | Terminal unit | 40 | 4 | 4 | 0.125 |
| 145 | 23 | window units | 515.2 | 52 | 52 | 1.5 |
| 151 | 2 | window units | 34.6 | 4 | 4 | 0.125 |
| 155 | 8 | window units | 138.4 | 14 | 14 | 0.5 |
| 154 | 4 | window units | 69.2 | 8 | 8 | 0.25 |
| 157 | 2 | window units | 33.3 | 4 | 4 | 0.125 |
| 158 | 16 | window units | 149.2 | 15 | 15 | 0.5 |
| 159 | 1 | furnace | 16.7 | 3 | 3 | 0.125 |

This ECO includes the implementation of both Phases I and II. If Phase 2 is not implemented install piping stub outs with cutoff valves on the primary HW loop for future HW conversion of the listed buildings in Table 2.

A. Discussion:

Phase 1 - All of the above buildings are historical buildings. Many of these buildings are served by HW boilers. Most of these boilers are natural draft fire tube boilers which are very inefficient. The efficiency of the boilers ranges from 60% to 70%. They generally appear to be in fair condition, but many older boilers show indications of rusting and leaks. Additionally, the cost of maintaining so many boilers is excessive and difficult for the maintenance staff. One reason is that these boilers are manufactured by several different manufacturers which require large PM and repair part inventory. It is recommended that a central boiler plant, consisting of two 2000 MBH high efficiency modular gas fired HW boilers will be installed. These boilers are 86% efficient under full load conditions, and reaching upwards to 98% efficiency under part load conditions. Moreover, these boilers have the capability to be staged to maintain these part load efficiencies by remote boiler control. Another advantage of the modular boiler is its compactness. The size of the boilers make it very economical in replacement projects that require tight space constraints. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. This will save heating energy and greatly reduce the maintenance cost of the installation.

Phase II - Buildings indicated in Table-2 will be furnished with new FCUs and new secondary HW pumps. Their sizes are listed in Table 2. FCUs are selected over the AHUs because of the ease of construction and because of the historical significance of the area. Vertical convector type FCUs can be installed fairly easily in the place of the existing equipment without damaging the antiquity of the buildings.

The DX coil split system will be removed from Buildings 127, 144 and 159. New horizontal ceiling mounted fan coils will replace the existing AHUs. Building 123 has five existing furnaces that will be replaced with six FCUs.

Computer simulations of the buildings in this area determined that the current installed capacity of 11,089 MBH is more than required to adequately heat the buildings[1]. Therefore it is recommended that two new boilers rated at a combined 4,000 MBH to more closely match the heating load of the buildings be installed.

B. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed boilers and pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3].

The 2000 MBH high efficiency modular boilers have better part load performance ratings than larger firetube or watertube boilers. Moreover, the ease of retrofitting existing equipment with these smaller footprint boilers makes them very cost effective. Full and part load performance data from Aerco Incorporated were used in the computer simulations of the new boiler energy usage. An equipment list of the specific boiler and pumps modeled for the new central plant is shown on page B-18.

Once the computer simulations of the existing and new boiler plants were completed, the total annual energy consumption of the new central plant was compared with that of the existing individual systems to determine the annual savings for this ECO. These savings calculations are shown on pages B-19 through B-21. These energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of boilers, window units, unit heaters, and gas fired furnaces in this area down to two modular boilers. The total maintenance cost savings from this ECO is estimated to be $91,980 per year as shown on page B-27 . This figure was used in the life cycle cost analysis.

C. Cost Estimates:

The total installation costs for the new central chiller plant were estimated on pages B-22 through B-26. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page B-28. The data from the summary sheet were presented in the ECO summary on page B-13.

## REFERENCES

1. See Appendix H for Area 100 heating system thermal profile.

2. See Appendix A for utility cost analysis data used in the savings calculations.

3. See Appendix G for building field data and existing HVAC field data.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-C, FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Hot Water Boiler | 2 | Aerco #KC-2000 GWB<br>natural draft, watertube<br>1830 MBH output | Area 2200 | New | 2,000 MBH |
| Heating Water Pump | 2 | Bell & Gossett<br>172 gpm, 110 ft<br>10 HP | Area 2200 | New | 7.50 KW |
| | | | | | |
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| ITEM | ECO C - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldgs. 122 & 140 Boiler | | | | | | | | | | | | | | 175 |
| Bldgs. 122 & 140 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 372 | |
| Bldgs. 124 & 125 Boiler | | | | | | | | | | | | | | 164 |
| Bldgs. 124 & 125 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 369 | |
| Bldg. 128 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 128 HW Controls | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | 0 | |
| Bldg. 133 Boiler | | | | | | | | | | | | | | 160 |
| Bldg. 133 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 133 Boiler Fan | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 16,203 | |
| Bldgs. 134 & 135 Boiler | | | | | | | | | | | | | | 46 |
| Bldgs. 134 & 135 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 218 | |
| Bldg. 143 Boiler | | | | | | | | | | | | | | 96 |
| Bldg. 143 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 322 | |
| Bldg. 144 Boiler | | | | | | | | | | | | | | 96 |
| Bldg. 144 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 322 | |
| Bldg. 145 Furnace | 13.7 | 14.6 | 9.3 | 1.5 | | | | | | | 8.3 | 13.9 | 8,840 | |
| Bldg. 146 Boiler | | | | | | | | | | | | | | 91 |
| Bldg. 146 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 305 | |
| Bldg. 147 Boiler | | | | | | | | | | | | | | 52 |
| Bldg. 147 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 211 | |
| Bldg. 149 Boiler | | | | | | | | | | | | | | 52 |
| Bldg. 149 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 211 | |
| Bldg. 197 Boiler | | | | | | | | | | | | | | 67 |
| Bldg. 197 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 134 | |
| Bldg. 198 Boiler | | | | | | | | | | | | | | 29 |
| Bldg. 198 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 180 | |
| Bldg. 199 Boiler | | | | | | | | | | | | | | 86 |
| Bldg. 199 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 127 Furnace | | | | | | | | | | | | | | 14 |
| Bldg. 127 Furnace Fan | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | 0.7 | 0.7 | 3,154 | |
| Bldg. 250 Boiler | | | | | | | | | | | | | | 103 |
| Bldg. 250 Boiler Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 300 | |
| Bldg. 142 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 142 HW Controls | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 0 | |
| Bldg. 123 Unit Heater | | | | | | | | | | | | | | 43 |
| Bldg. 123 Unit Heater Fan | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 403 | |
| Bldg. 126 Boiler | | | | | | | | | | | | | | 94 |
| Bldg. 126 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 230 | |
| Bldg. 131 Boiler | | | | | | | | | | | | | | 98 |
| Bldg. 131 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 129 Boiler | | | | | | | | | | | | | | 40 |
| Bldg. 129 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 151 Resistance Heater | 3.4 | 3.6 | 1.3 | 0.2 | | | | | | | 1.5 | 3.4 | 2,866 | |
| Bldg. 154 Resistance Heater | 5.4 | 5.8 | 3.0 | 0.3 | | | | | | 0.7 | 2.8 | 5.5 | 6,203 | |
| Bldg. 156 Boiler | | | | | | | | | | | | | | 33 |
| Bldg. 156 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 313 | |
| Bldg. 157 Unit Heater | | | | | | | | | | | | | | 13 |

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| ITEM | ECO C - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 157 Unit Heater Fan | 15.0 | 13.0 | 15.0 | 14.0 | | | | | | | 14.0 | 15.0 | 87 | |
| Bldg. 159 Unit Heater | | | | | | | | | | | | | | 0 |
| Bldg. 159 Unit Heater Fan | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 0 | |
| Bldg. 152 Unit Heater | | | | | | | | | | | | | | 89 |
| Bldg. 152 Unit Heater Fan | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 599 | |
| Bldg. 155 Boiler | | | | | | | | | | | | | | 32 |
| Bldg. 155 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 158 Unit Heater | | | | | | | | | | | | | | 56 |
| Bldg. 158 Unit Heater Fan | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 500 | |
| Bldg. 141 Resistance Heater | 3.7 | 3.7 | 2.1 | 0.2 | | | | | | | 2.1 | 3.7 | 4,295 | |
| Bldgs. 260 & 261 Boiler | | | | | | | | | | | | | | 25 |
| Bldgs. 260 & 261 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 268 Boiler | | | | | | | | | | | | | | 83 |
| Bldg. 268 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| | | | | | | | | | | | | | | |
| Totals | 48.1 | 47.6 | 37.6 | 23.1 | | | | | | 0.7 | 35.6 | 48.4 | 50,438 | 1,835 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 361 | 357 | 282 | 173 | | | | | | 5 | 267 | 363 | | |

| | | |
|---|---|---|
| Total Demand | 1,808 $/yr | |
| Total Energy | 172 MMBTU/yr | (electric) |
| Total Energy | 1,835 MMBTU/yr | (gas) |

| ITEM | ECO-C: NEW BOILER PLANT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| High % modular boiler | | | | | | | | | | | | | | 1,499 |
| HW pump | 7.5 | 7.5 | 7.5 | 7.5 | | | | | | | 7.5 | 7.5 | 32,580 | |
| HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| High % modular boiler | | | | | | | | | | | | | | 21 |
| HW pump | 7.5 | 7.5 | | | | | | | | | | 7.5 | 713 | |
| HW controls | 0.1 | 0.1 | | | | | | | | | | 0.1 | 12 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 15.2 | 15.2 | 7.6 | 7.6 | | | | | | | 7.6 | 15.2 | 33,848 | 1,520 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 114 | 114 | 57 | 57 | | | | | | | 57 | 114 | | |

| | | | |
|---|---|---|---|
| Total Demand | 513 | $/yr | |
| Demand Savings | 1,295 | $/yr | |
| Energy Savings | 57 | MMBTU/yr | (electric) |
| Energy Savings | 314 | MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6C | | DATE: 9/18/96 |
| ECO NO. C Retrofit Existing Individual Boilers AREA 100 | BY : KOTHMANN, K | | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 1 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| REMOVE BOILER UP TO 500 MBH | 19 | EA | 24.0 | 28.91 | 13,183 | 500.00 | 9,500 | 22,683 |
| REMOVE BOILER 500 MBH AND UP | 7 | EA | 48.0 | 28.91 | 9,714 | 780.00 | 5,460 | 15,174 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 5" | 6,000 | LF | 0.9 | 28.91 | 156,114 | 27.50 | 165,000 | 321,114 |
| 2-1/2" | 120 | LF | 0.5 | 28.91 | 1,735 | 13.33 | 1,600 | 3,334 |
| 2" | 1,520 | LF | 0.4 | 28.91 | 17,577 | 13.55 | 20,596 | 38,173 |
| 1-1/2" | 540 | LF | 0.4 | 28.91 | 6,245 | 12.85 | 6,939 | 13,184 |
| 1" | 640 | LF | 0.35 | 28.91 | 6,476 | 11.55 | 7,392 | 13,868 |
| SUBTOTAL | | | | | 211,043 | | 216,487 | 427,530 |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| TOTAL | | | | | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.C6
**DATE:** 9/18/96

**ECO NO. C** Retrofit Existing Individual Boilers AREA 100
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 5" | 8 | EA | 20.0 | 28.91 | 4,626 | 540.00 | 4,320 | 8,946 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 500.0 | 20.00 | 10,000 | 9,000.00 | 9,000 | 19,000 |
| SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING HW PUMPS PER LOCATION | | | | | | | | |
| 2-1/2" | 1 | LOC | 9.6 | 28.91 | 278 | 639.00 | 639 | 917 |
| 1-1/2" TO 1" | 20 | LOC | 8.0 | 28.91 | 4,626 | 600.00 | 12,000 | 16,626 |
| ALL AIR SIDE EQUIPMENT INCLUDED IN ECO B | | | | | | | | |
| ADD PIPING ASSEMBLY &HOT WTR COIL | | | | | | | | |
| VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY | 6 | EA | 10.0 | 28.91 | 1,735 | 1,200.00 | 7,200 | 8,935 |
| AHU W/ HW COIL 2-PIPE 2000 CFM | 2 | EA | 14.5 | 28.91 | 838 | 1,100.00 | 2,200 | 3,038 |
| | | | | SUBTOTAL | 22,102 | | 35,359 | 57,461 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FT SAM HOUSTON , SAN ANTONIO TEX

**ECO NO. C** Retrofit Individual Boilers AREA 100

**PROJECT NO:** 03-185.6C **DATE:** 9/18/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install New Boiler AERCO # KC 2000 1830 MBH | 2 | EA | 100.00 | 28.91 | 5,782 | 18500.00 | 37,000 | 42,782 |
| Install New Pump 10 HP | 2 | EA | 15.00 | 28.91 | 867 | 2800.00 | 5,600 | 6,467 |
| pipe Assembly & valves Boiler | 2 | EA | 28.00 | 28.91 | 1,619 | 2400.00 | 4,800 | 6,419 |
| pipe Assembly & valves Pump | 2 | EA | 12.00 | 28.91 | 694 | 1350.00 | 2,700 | 3,394 |
| Boiler Breaching | 1 | JOB | 50.00 | 28.91 | 1,446 | 2500.00 | 2,500 | 3,946 |
| Controls | 1 | JOB | 160.00 | 28.91 | 4,626 | 6900.00 | 6,900 | 11,526 |
| Electrical | 1 | JOB | 100.00 | 28.91 | 2,891 | 5900.00 | 5,900 | 8,791 |
| Chemical Shot Feed | 1 | JOB | 16.00 | 28.91 | 463 | 1500.00 | 1,500 | 1,963 |
| Test , Balance & Start-up | 1 | LS | 160.00 | 28.91 | 4,626 | | | 4,626 |
| | | | | SUBTOTAL | 23,012 | | 66,900 | 89,912 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. C Retrofit Existing Individual Boilers AREA 100

PROJECT NO: 03-185.6C

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
PHASE TWO 52497 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE GAS FIRED SPACE HTR | 5 | EA | 4.0 | 22.00 | 440 | 10.00 | 50 | 490 |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 1" | 1,100 | LF | 0.3 | 28.91 | 10,176 | 10.65 | 11,715 | 21,891 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 250 | LF | 0.5 | 28.91 | 3,614 | 7.05 | 1,763 | 5,376 |
| 1-1/2" | 525 | LF | 0.4 | 28.91 | 6,071 | 5.05 | 2,651 | 8,722 |
| 1" | 1,000 | LF | 0.3 | 28.91 | 8,673 | 4.38 | 4,380 | 13,053 |
| 3/4" | 2,100 | LF | 0.3 | 28.91 | 18,213 | 2.75 | 5,775 | 23,988 |
| | | | | SUBTOTAL | 47,187 | | 26,334 | 73,521 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6C
**DATE:** 9/18/96

**ECO NO. C** Retrofit Existing Individual Boilers AREA 100
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
PHASE TWO 52497 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , HW ENTRY PIPING ASSEMBLY 1" | 11 | LOC | 14.0 | 28.91 | 4,452 | 1,300.00 | 14,300 | 18,752 |
| AND NEW HOT WTR PUMPS COST PER LOCATION | | | | | | | | |
| ALL AIR SIDE EQUIPMENT INCLUDED IN ECO B | | | | | | | | |
| ADD PIPING ASSEMBLY & HOT WTR COIL | | | | | | | | |
| 3/4" CONTROL VALVE 2- WAY | 3 | EA | 4.0 | 28.91 | 347 | 595.00 | 1,785 | 2,132 |
| 1/2" " " 3-WAY | 7 | EA | 4.0 | 28.91 | 809 | 475.00 | 3,325 | 4,134 |
| 1/2" " " 2 - WAY | 55 | EA | 4.0 | 28.91 | 6,360 | 450.00 | 24,750 | 31,110 |
| SUB TOTAL FROM SHEET 1 | | | | | 211,043 | | 216,487 | 427,530 |
| SUB TOTAL FROM SHEET 2 | | | | | 22,102 | | 35,359 | 57,461 |
| SUB TOTAL FROM SHEET 3 | | | | | 23,012 | | 66,900 | 89,912 |
| SUB TOTAL FROM SHEET 4 | | | | | 47,187 | | 26,334 | 73,521 |
| SUBTOTAL | | | | | 315,313 | | 389,239 | 704,553 |
| O & P @ 20% | | | | | 63,063 | | 77,848 | 140,911 |
| SUBTOTAL | | | | | 378,376 | | 467,087 | 845,463 |
| DESIGN @ 6% | | | | | | | | 50,728 |
| SUBTOTAL | | | | | | | | 896,191 |
| SIOH @ 5.5% | | | | | | | | 49,291 |
| TOTAL | | | | | | | | $945,481 |


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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-0185.6MA

DATE: 9/18/96

ECO NO. C Retrofit Existing BOILERS

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment AREA 100

ANNUAL COSTS

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER BOILER PER YEAR | | | | | | | | |
| EXISTING BOILER | -21. | EA | 100.0 | 30.00 | -63,000 | 1,800.00 | -37,800 | -100,800 |
| **NEW EQUIPMENT** | | | | | | | | |
| AERCO MODULAR HIGH EFFICIENCY HW BOILER | 2. | EA | 80.0 | 30.00 | 4,800 | 1,500.00 | 4,020 | 8,820 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -58,200 | | -33,780 | -91,980 |

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(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis — Study: FSH-100.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: FORT SAM HOUSTON

Region data: TEXAS Census Region: 3

Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY

Fiscal Year: 1996 Discrete Portion: ECO-C

Analysis Date: 08/30/96 Economic Life: 20 years

Prepared by: Michael W. Elliott, P.E., C.E.M.

## ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | $845,463 |
| B. | SIOH | $49,291 |
| C. | Design Cost | $50,728 |
| D. | Total Cost (1A+1B+1C) | $945,482 |
| E. | Salvage Value of Existing Equip. | $0 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $945,482 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 57 | Mbtus | $358 | 15.08 | $5,398 |
| Elec. Deman | | | | | $1,295 | 14.88 | $19,270 |
| Natural Gas | $4.4 | /Mbtus | 314 | Mbtus | $1,378 | 18.58 | $25,612 |
| TOTAL | | | 371 | Mbtus | $3,031 | | $50,279 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $91,980 | Annual | 14.88 | $1,368,662 |
| ANNUAL TOTAL | $91,980 | | | $1,368,662 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $91,980 | | | $1,368,662 |

| | |
|---|---|
| 4. First Year Dollar Savings | $95,011 |
| 5. Simple Payback Period (Years) | 9.95 |
| 6. Total Net Discounted Savings | $1,418,942 |
| 7. Savings to Investment Ratio | 1.5 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 5.11% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | A |
| DATE: | 3/1/96 |
| ECO TITLE: | Install Energy Management System (EMS) For HVAC System |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 100 (serving buildings 122, 123, 124, 125, 126, 127, 128, 129, 131,133, 134, 135, 140, 141,142, 143, 144,145, 146, 147, 149, 151, 152, 154, 155, 156, 157, 158, 159, 197, 198, 199, 250, 260, 261 and 268) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 5928 | MMBTU/yr |
| Electrical Demand Savings | -2523 | $/yr |
| Gas Energy Savings | 691 | MMBTU/yr |
| Total Energy Savings | 6619 | MMBTU/yr |
| Total Cost Savings | 37,738 | $/yr |
| Total Investment | 928,408 | $ |
| Simple Payback | 24.6 | yrs |
| SIR | 0.62 | |

B. ECO Description:

Install an Energy Management System (EMS) at the central maintenance facility. The EMS will accomplish the following tasks for the equipment listed in Table-1 for all of the above mentioned buildings.

1. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature.

2. A night / day setback program will be provided to control window units and fan coil units, and split systems. The program will set back the temperature of the controlled space to a predetermined set-point during periods of no occupancy. Several space or unit mounted temperature sensors will be installed to control the units that currently are controlled under manual operation or no control.

Table-1

| Building # | Equipment To Be Controlled |
|---|---|
| 122 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 123 | Cooling tower, CND pump, 6 water cooled package units, 5 space heaters. |
| 124 | Chiller, 2 CHW pumps, AHUs, Boiler and 2 HW pumps. |
| 125 | AHU |
| 126 | Chiller, CHW pump, AHU, Boiler and HW pump. |
| 127 | A split system and furnace. |
| 128 | Chiller, CHW pump, AHU, Boiler and HW pump. |
| 129 | Chiller, CHW pump, AHU, Boiler and HW pump. (computer rm. units not included) |
| 131 | Chiller, CHW pump, 2 AHUs, Boiler HW pump, Side wall exh. and supply fans, 1 FCU |
| 133 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 135 | AHUs |
| 140 | AHU |
| 141 | 2 window units |
| 142 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 143 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 144 | Chiller, CHW pump, AHUs, Boiler and HW pump. (computer rm. units not included) |
| 145 | 23 window units |
| 146 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 147 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 149 | AHUs, Boiler and HW pump. |
| 151 | 2 window units |
| 152 | 2 window units, 10 gas fired space heaters. |
| 154 | 4 window units |
| 155 | Chiller, CHW pump, AHUs, Boiler, HW pump and a FCU |
| 156 | 4 window units. Boiler and HW pump. |
| 157 | 2 window units, 2 gas fired space heaters. |
| 158 | 8 window units, 8 gas fired floor furnaces. |
| 159 | 1 window units, 1 gas fired space heaters. 1 split system. |
| 197 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 198 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 199 | Chiller, CHW pump, AHUs, Boiler and HW pump. |
| 250 | Chiller, CHW pump, AHUs, 2 Boilers. |
| 260 & 261 | Chiller, CHW pump, 10 FCUs, Boiler and HW pump. |
| 268 | Chiller, CHW pump, 3 FCUs, 1 AHU, Boiler and HW pump. |

3. All multi-zone units and all single zone units with or without reheat coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures after the reheat coil (RH) will be monitored. The cooling coil leaving air temperature will be reset sufficiently to satisfy at least one zone thermostat without reheat.

4. All multi-zone units will have air side temperature reset. AHU heating leaving air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full

5. All chillers will have water temperature reset. The leaving CHW temperature will be reset to satisfy varying load conditions.

C. Discussion:

1. Generally most buildings in this area are occupied from 7:30 a.m. to 4:30 p.m. daily with some exceptions. The facility remains unoccupied during the weekends and holidays. Regardless of occupancy hours, all AHU's are operated 24 hours per day, 365 days per year to maintain space temperature. However, the chillers operate only during the cooling season (with the exception of building 268) as do the boilers in the heating season. Depending on occupancy schedules, ambient conditions and building thermal characteristics, most AHU's and their associated chillers, boilers , CHW and HW pumps will be turned off daily in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHU's will remain off during weekends and holidays.

Several temperature sensors will be installed in the spaces served by these AHU's. These sensors will monitor the space temperature during unoccupied hours. During the cooling season when the space temperature exceeds 85°F, the AHU's and their associated cooling auxiliaries serving that space will energize to cool the space below 85°F. When the space temperature reaches 80°F, they will cycle off. Similarly, the winter time unoccupied period space temperature will be maintained at 65 F.

The EMS system will have the capability to manually override this operation with a change in schedule. All AHU's serving the critical areas such as computer room unit will operate as usual, and they will not be connected to the new start/stop program. However, if desired, their current operation and performance can be monitored by the new EMS system.

2. During periods when the facility remains unoccupied, the window units, fan coil units and split systems that serve non-critical areas will be reset to an "unoccupied" space temperature condition. Temperature sensors will monitor the space temperature at all times, and when the program determines the unoccupied periods, the temperature setpoint will rise from 78°F to 85°F for summer cooling conditions and from 70°F to 65°F for winter heating conditions. When the space temperature exceeds 85°F during unoccupied periods, then it will energize the unit and its associated auxiliary cooling equipment. Similarly, when the space temperature falls below 65°F during unoccupied periods, then it will energize the unit and its associated auxiliary heating equipment.

3. The EMS will have the capability to override this operation with a change in schedule or function. Also, this will not apply to window units, fan coil units, and split systems serving critical areas such as computer rooms. These units will operate as usual, and they will connected to the new start stop program unless their operation and performance needs to be monitored.

Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's. (For all boilers and chillers that have a seasonal operation, the hot and cold

the AHU's. (For all boilers and chillers that have a seasonal operation, the hot and cold air mixing never occurs. Return air mixes with the cold air in summer and with hot air in the winter.) In both cases cooling energy is wasted. To reduce this waste, currently the hot air plenum is acting as a return air plenum. Our observations indicate that all zones are mixing cold supply and return air to maintain the room or designated zone area temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur.

In multi-zone units, cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Our observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. Heating supply air temperature will be lowered until at least one zone damper is fully open to satisfy the room or area heating demand. Many partially open heating dampers indicate a higher than necessary heating deck temperature. Lowering this temperature will save heating energy.

5. Chillers at Building 250 will be furnished with chilled water temperature reset controls. Upon a decrease in ambient temperature, the leaving CHW temperature will increase. An increase in leaving CHW temperature decreases the KW/ton which will reduce the electrical energy required. Application of this type of controls on smaller chillers (50 ton or less) will be uneconomical. Also, a few of the small reciprocating chillers are equipped with water cooled condensers. Economics makes condenser water reset similar to that of chilled water not feasible. The chillers at Building 250 are air cooled.

The EMS system will be controlled by a personal computer (PC) located at the central maintenance facility building. All other building control panels will be connected to the central EMS system PC in the building via telephone lines.

Bin temperature data for San Antonio, Texas, S.A. and R.A. temperatures, and CHW temperature data were entered in the Trace 600 computer program to calculate energy savings through this option (ref. Appendix H for data input and page C-6 for the estimated EMS point list.).

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing system and the proposed EMS system were calculated using the Trace 600 computer program [1]. The buildings served by the existing chillers were modeled by the computer to provide a

realistic load profile. Field data obtained from the buildings were used to create these computer building models [2].

Once the computer simulations of the existing and new EMS systems were completed, the total annual demand cost and energy consumption were compared with that of the existing and new systems to determine the annual savings for this ECO [3]. These savings calculations are shown starting on pages C-8. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings associated with this ECO.

E. Cost Estimates:

The total installation costs for the new EMS system is estimated on page C-18. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-21. The data from the summary sheet were presented in the ECO summary on page C-1.

## REFERENCES

1. See Appendix H for computer model input assumptions, data, and energy consumption output from Trace 600.
2. See Appendix G for building field data and existing HVAC system data.
3. See Appendix A for utility cost analysis data used in the savings calculations.

AREA: 100

ECO A: INSTALL EMS FOR HVAC EQUIPMENT

OCCUPANCY TIME: VARIES

| | HARDWARE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | | | | | | |
| POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | DIFFERENITAL PRESSURE | GAGE PRESSURE | | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE |
| GRAPHIC DISPLAY ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| A/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 19 | | | | | | | | | | | | | | | | | | | | | | | |
| CHW PUMP | 23 | | | | | | | | | | | | | | 23 | | | | | | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 19 | | | | | | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 19 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COOLING TOWER | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TWR. FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | |
| CW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | |
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| HW BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 21 | | | | | | | 21 | | | | | | | | | | | | | | | | |
| HW PUMP | 25 | | | | | | | | | | | | | | 25 | | | | | | | | | | | | | |
| HW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 21 | | | | | | | | | | |
| HW RETURN HEADER | | | | | | | | | | | | | | | | | | 21 | | | | | | | | | | |
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| STEAM BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 2 | | | | | | | 2 | | | | | | | | | | | | | | | | |
| STEAM SUPPLY HEADER | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | |
| STEAM RETURN HEADER | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | |
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| AHU-SZ ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 10 | | | | | | | | | | | | | | 10 | | | | | | | | | | | | | |
| CHW COIL VALVE | | | | | | 10 | | | | | | | | | | | | 10 | | | | | | | | | | |
| HW COIL VALVE | | | | | | 10 | | | | | | | | | | | | 10 | | | | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FILTER | | | | | | | | | | 10 | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 10 | | | | | | | | | | |
| OUTSIDE AIR | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| AHU-CLG ONLY SZ ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 1 | | | | | | | | | | | | 1 | | | | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FILTER | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| OUTSIDE AIR | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



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| INPUT | | | | | | | | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | |
| | | | | ANALOG | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | DIFFERENITAL PRESSURE | GAGE PRESSURE | | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | |
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| | | | | 21 | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | |
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| SOFTWARE | | | | | | | | | | | | | | | | | | | | | | | | |
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| APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | | | |
| SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | | | REMARKS |
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AREA: 100

ECO A: INSTALL EMS FOR HVAC EQUIPMENT

OCCUPANCY TIME: VARIES

| | HARDWARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | | | | | | | |
| GRAPHIC DISPLAY ● / POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | DIFFERENITAL PRESSURE | GAGE PRESSURE | | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AHU (MZ) ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 28 | | | | | | | | | | | | | | 28 | | | | | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 28 | | | | | | | | | | | | 28 | | | | | | | | | | | |
| HOT DECK TEMP. | | | | | | 28 | | | | | | | | | | | | 28 | | | | | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 28 | | | | | | | | | | | |
| ZONE DAMPERS | | | | | | | 56 | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 56 | | | | | | | | | | | |
| FILTER | | | | | | | | | | 28 | | | | | | | | | | | | | | | | | | | X |
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| FAN COIL UNIT ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 20 | | | | | | | | | | | |
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| PACKAGED AHU ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 6 | | | | | | | | | | | |
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| PACKAGED WINDOW UNIT ● | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 56 | | | | | | | | | | | |
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| OUTSIDE AIR ● | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | |
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TOTAL AO POINTS = 131

TOTAL DO POINTS = 133

TOTAL AI POINTS = 151

TOTAL DI POINTS = 339

GRAND TOTAL POINTS = 754

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INPUT | | | | | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | |
| | ANALOG | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | DIFFERENITAL PRESSURE | GAGE PRESSURE | | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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2

SOFTWARE

APPLICATION PROGRAMS

| | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| | | | X | | | | | | | | | | | | | | | | | X | | | | | | all valves, dampers, thermostats, and |
| | | | | | | | | | X | | | | | | | | | | | | | | | | | actuators are existing. |
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| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldgs. 122 & 140 Chiller | | | | | 53.2 | 59.2 | 63.7 | 62.9 | 53.4 | 38.7 | | | 105,589 | |
| Bldgs. 122 & 140 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldgs. 122 & 140 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 122 & 140 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldgs. 124 & 125 Chiller | | | | | 58.7 | 65.2 | 69.7 | 68.4 | 58.3 | 42.8 | | | 114,027 | |
| Bldgs. 124 & 125 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldgs. 124 & 125 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 124 & 125 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldg. 128 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 128 CHW Pump | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 128 CHW Controls | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 133 Chiller | | | | | 36.9 | 41.7 | 44.8 | 44.4 | 38.3 | 27.1 | | | 79,446 | |
| Bldg. 133 CHW Pump | | | | | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | | | 4,946 | |
| Bldg. 133 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 134 & 135 Chiller | | | | | 49.6 | 51.8 | 53.8 | 53.3 | 49.8 | 45.5 | | | 109,087 | |
| Bldgs. 134 & 135 CHW Pump | | | | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | | 1,634 | |
| Bldgs. 134 & 135 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 143 Chiller | | | | | 56.9 | 61.9 | 66.7 | 67.5 | 58.5 | 45.7 | | | 106,683 | |
| Bldg. 143 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldg. 143 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 144 Chiller | | | | | 4.4 | 4.5 | 4.5 | 4.7 | 4.9 | 3.4 | | | 10,120 | |
| Bldg. 144 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 8,732 | |
| Bldg. 144 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,898 | |
| Bldg. 144 Chiller | | | | | 52.3 | 56.8 | 61.2 | 61.9 | 53.7 | 41.9 | | | 83,823 | |
| Bldg. 144 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 5,952 | |
| Bldg. 144 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,657 | |
| Bldg. 145 Window Units | | | | | 51.9 | 54.0 | 56.0 | 55.5 | 52.0 | 48.6 | | | 48,756 | |
| Bldg. 145 Window Unit Fans | | | | | 4.8 | 5.2 | 7.4 | 7.4 | 5.0 | 3.8 | | | 7,225 | |
| Bldg. 145 Window Unit Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 442 | |
| Bldg. 146 Chiller | | | | | 54.7 | 59.5 | 64.2 | 64.9 | 56.2 | 44.1 | | | 106,939 | |
| Bldg. 146 CHW Pump | | | | | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | | | 4,946 | |
| Bldg. 146 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 147 & 149 Chiller | | | | | 81.0 | 86.4 | 89.6 | 88.9 | 82.6 | 70.8 | | | 176,040 | |
| Bldgs. 147 & 149 CHW Pump | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,472 | |
| Bldgs. 147 & 149 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 197 Chiller | | | | | 56.1 | 61.1 | 65.6 | 65.9 | 57.7 | 45.7 | | | 106,257 | |
| Bldg. 197 CHW Pump | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 6,580 | |
| Bldg. 197 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 198 Condenser | | | | | 13.2 | 14.1 | 14.7 | 14.5 | 13.6 | 10.1 | | | 20,362 | |
| Bldg. 198 Condenser Fans | | | | | 1.7 | 1.8 | 1.8 | 1.8 | 1.8 | 1.4 | | | 2,731 | |
| Bldg. 198 CHW Pump | | | | | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | | | 4,946 | |
| Bldg. 198 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 199 Chiller | | | | | 21.6 | 24.1 | 26.4 | 26.6 | 22.7 | 16.4 | | | 46,260 | |
| Bldg. 199 CHW Pump | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 6,580 | |
| Bldg. 199 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 127 Condenser | | | | | 6.6 | 6.9 | 7.1 | 7.1 | 6.6 | 6.1 | | | 10,166 | |
| Bldg. 127 Condenser Fans | | | | | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | | | 956 | |
| Bldg. 127 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 250 Chiller | | | | | 140.8 | 150.4 | 162.3 | 166.0 | 145.0 | 110.5 | | | 315,629 | |
| Bldg. 250 CHW Pump | | | | | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | | | 24,730 | |

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 250 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 122 Fans | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 71,832 | |
| Bldg. 140 Fans | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 6,132 | |
| Bldg. 124 Fans | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 71,832 | |
| Bldg. 125 Fans | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 134,200 | |
| Bldg. 128 Fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 65,700 | |
| Bldg. 133 Fans | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 71,832 | |
| Bldg. 134 Fans | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 147,220 | |
| Bldg. 135 Fans | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 147,220 | |
| Bldg. 143 Fans | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 143,500 | |
| Bldg. 144 Fans | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 151,469 | |
| Bldg. 145 Fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 65,700 | |
| Bldg. 146 Fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 65,700 | |
| Bldg. 147 Fans | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 58,692 | |
| Bldg. 149 Fans | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,540 | |
| Bldg. 197 Fans | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 62,401 | |
| Bldg. 198 Fans | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 28,035 | |
| Bldg. 199 Fans | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 19,272 | |
| Bldg. 127 Fans | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,649 | |
| Bldg. 250 Fans | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Bldg. 250 Fans | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 297,840 | |
| Bldgs. 122 & 140 Boiler | | | | | | | | | | | | | | 175 |
| Bldgs. 122 & 140 HW Pump | 1.1 | 1.1 | 1.1 | 1.1 | | | | | | | 1.1 | 1.1 | 3,335 | |
| Bldgs. 122 & 140 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 372 | |
| Bldgs. 122 & 140 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 9,557 | |
| Bldgs. 124 & 125 Boiler | | | | | | | | | | | | | | 164 |
| Bldgs. 124 & 125 HW Pump | 1.1 | 1.1 | 1.1 | 1.1 | | | | | | | 1.1 | 1.1 | 3,308 | |
| Bldgs. 124 & 125 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 369 | |
| Bldgs. 124 & 125 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 9,557 | |
| Bldg. 128 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 128 HW Pump | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | 0 | |
| Bldg. 128 HW Controls | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | 0 | |
| Bldg. 133 Boiler | | | | | | | | | | | | | | 160 |
| Bldg. 133 HW Pump | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | 0.4 | 0.4 | 1,607 | |
| Bldg. 133 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 133 Boiler Fan | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 16,203 | |
| Bldgs. 134 & 135 Boiler | | | | | | | | | | | | | | 46 |
| Bldgs. 134 & 135 HW Pump | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | 0.4 | 0.4 | 646 | |
| Bldgs. 134 & 135 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 218 | |
| Bldg. 143 Boiler | | | | | | | | | | | | | | 96 |
| Bldg. 143 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,932 | |
| Bldg. 143 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 322 | |
| Bldg. 144 Boiler | | | | | | | | | | | | | | 96 |
| Bldg. 144 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,932 | |
| Bldg. 144 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 322 | |
| Bldg. 145 Furnace | 13.7 | 14.6 | 9.3 | 1.5 | | | | | | | 8.3 | 13.9 | 8,840 | |
| Bldg. 146 Boiler | | | | | | | | | | | | | | 91 |
| Bldg. 146 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,932 | |
| Bldg. 146 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 305 | |
| Bldg. 147 Boiler | | | | | | | | | | | | | | 52 |

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 147 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,264 | |
| Bldg. 147 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 211 | |
| Bldg. 149 Boiler | | | | | | | | | | | | | | 52 |
| Bldg. 149 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,264 | |
| Bldg. 149 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 211 | |
| Bldg. 197 Boiler | | | | | | | | | | | | | | 67 |
| Bldg. 197 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 802 | |
| Bldg. 197 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 134 | |
| Bldg. 198 Boiler | | | | | | | | | | | | | | 29 |
| Bldg. 198 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 804 | |
| Bldg. 198 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 180 | |
| Bldg. 199 Boiler | | | | | | | | | | | | | | 86 |
| Bldg. 199 HW Pump | 1.1 | 1.1 | 1.1 | 1.1 | | | | | | | 1.1 | 1.1 | 4,865 | |
| Bldg. 199 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 127 Furnace | | | | | | | | | | | | | | 14 |
| Bldg. 127 Furnace Fan | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | 0.7 | 0.7 | 3,154 | |
| Bldg. 250 Boiler | | | | | | | | | | | | | | 103 |
| Bldg. 250 Boiler Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 300 | |
| Bldg. 142 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 142 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 142 CHW Pump | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 142 CHW Controls | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 123 Chiller | | | | | 13.1 | 13.3 | 14.1 | 14.5 | 13.4 | 10.2 | | | 34,487 | |
| Bldg. 123 Cooling Tower Fans | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 5,893 | |
| Bldg. 123 CND Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,093 | |
| Bldg. 123 CHW Controls | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 413 | |
| Bldg. 123 Humidifier | | | | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | | | 3,997 | |
| Bldg. 126 Chiller | | | | | 40.4 | 43.8 | 47.1 | 47.9 | 43.3 | 35.0 | | | 86,201 | |
| Bldg. 126 CHW Pump | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 6,580 | |
| Bldg. 126 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 131 Chiller | | | | | 32.7 | 35.7 | 38.3 | 38.2 | 35.4 | 27.8 | | | 69,516 | |
| Bldg. 131 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldg. 131 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 129 Chiller | | | | | 4.9 | 5.2 | 5.7 | 5.9 | 5.6 | 4.9 | | | 13,350 | |
| Bldg. 129 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 129 Chiller | | | | | 36.7 | 39.3 | 42.8 | 44.3 | 42.0 | 37.1 | | | 72,266 | |
| Bldg. 129 CHW Pump | | | | | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | | | 7,866 | |
| Bldg. 129 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,305 | |
| Bldg. 151 Window Units | 3.6 | 3.6 | 3.6 | 3.7 | 4.0 | 4.1 | 4.3 | 4.2 | 4.0 | 4 | 4 | 3.6 | 5,685 | |
| Bldg. 151 Window Unit Fans | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 733 | |
| Bldg. 151 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 434 | |
| Bldg. 154 Window Units | 7.0 | 7.0 | 7.0 | 7.3 | 7.7 | 8.1 | 8.3 | 8.3 | 7.8 | 7.3 | 7.0 | 7.0 | 7,197 | |
| Bldg. 154 Window Unit Fans | 0.1 | 0.0 | 0.2 | 0.4 | 0.5 | 0.6 | 1.0 | 1.0 | 0.6 | 0.3 | 0.2 | 0.1 | 978 | |
| Bldg. 154 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 379 | |
| Bldg. 156 Window Units | 0.0 | 0.0 | 13.1 | 13.8 | 14.6 | 15.2 | 15.8 | 15.7 | 14.7 | 13.7 | 13.1 | 0.0 | 7,055 | |
| Bldg. 156 Window Unit Fans | 0.0 | 0.0 | 0.2 | 0.3 | 0.5 | 0.5 | 1.8 | 1.8 | 0.5 | 0.3 | 0.2 | 0.0 | 986 | |
| Bldg. 156 Window Unit Controls | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 358 | |
| Bldg. 157 Window Units | 3.1 | 3.1 | 3.1 | 3.3 | 3.5 | 3.6 | 3.8 | 3.7 | 3.5 | 3.3 | 3.1 | 3.1 | 6,357 | |
| Bldg. 157 Window Unit Fans | 0.1 | 0.1 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.1 | 876 | |
| Bldg. 157 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 514 | |

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 159 Condenser | | | | | 3.6 | 3.7 | 3.8 | 3.8 | 3.4 | 2.3 | | | 10,476 | |
| Bldg. 159 Condenser Fans | | | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | | | 1,501 | |
| Bldg. 159 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 152 Window Units | 11.9 | 11.9 | 11.9 | 12.4 | 13.2 | 13.8 | 14.3 | 14.1 | 13.2 | 12.4 | 11.9 | 11.9 | 18,405 | |
| Bldg. 152 Window Unit Fans | 0.3 | 0.3 | 0.8 | 1.2 | 1.6 | 1.8 | 1.9 | 1.9 | 1.7 | 1.2 | 0.8 | 0.4 | 2,716 | |
| Bldg. 152 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 484 | |
| Bldg. 155 Condenser | 8.2 | 8.3 | 6.6 | 6.4 | 8.1 | 10.0 | 9.9 | 9.3 | 9.0 | 7.8 | 7.8 | 8.3 | 22,335 | |
| Bldg. 155 Condenser Fans | 0.6 | 0.4 | 0.7 | 0.7 | 0.8 | 1.0 | 1.0 | 1.0 | 0.9 | 0.8 | 0.7 | 0.5 | 2,305 | |
| Bldg. 155 CHW Pump | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 2,719 | |
| Bldg. 155 Condenser Controls | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 1,457 | |
| Bldg. 155 Window Units | 14.2 | 14.2 | 14.2 | 14.9 | 15.8 | 16.5 | 17.1 | 17.0 | 15.9 | 14.9 | 14.2 | 14.2 | 16,295 | |
| Bldg. 155 Window Unit Fans | 0.6 | 0.5 | 1.1 | 1.4 | 1.6 | 1.7 | 2.0 | 2.0 | 1.7 | 1.3 | 1.1 | 0.6 | 2,065 | |
| Bldg. 155 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 193 | |
| Bldg. 158 Window Units | 9.5 | 9.5 | 9.5 | 9.9 | 10.6 | 11.0 | 11.4 | 11.3 | 10.6 | 9.9 | 9.5 | 9.5 | 17,371 | |
| Bldg. 158 Window Unit Fans | 0.3 | 0.2 | 0.7 | 1.0 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 0.9 | 0.6 | 0.3 | 2,214 | |
| Bldg. 158 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 450 | |
| Bldg. 141 Window Units | 3.1 | 3.1 | 3.1 | 3.3 | 3.5 | 3.6 | 3.8 | 3.7 | 3.5 | 3.3 | 3.1 | 3.1 | 8,248 | |
| Bldg. 141 Window Unit Fans | 0.1 | 0.1 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.1 | 1,133 | |
| Bldg. 141 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 512 | |
| Bldgs. 260 & 261 Chiller | | | | | 18.3 | 19.9 | 21.1 | 20.9 | 18.3 | 14.6 | | | 35,084 | |
| Bldgs. 260 & 261 CHW Pump | | | | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | | 1,445 | |
| Bldgs. 260 & 261 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,906 | |
| Bldgs. 260 & 261 CHW Pump | | | | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | | 1,445 | |
| Bldg. 268 Chiller | 11.3 | 11.3 | 13.3 | 15.9 | 19.2 | 21.3 | 22.9 | 23.2 | 20.0 | 14.8 | 12.9 | 11.3 | 48,278 | |
| Bldg. 268 CHW Pump | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 2,981 | |
| Bldg. 268 CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 5,323 | |
| Bldg. 142 Fans | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,389 | |
| Bldg. 123 Fans | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 21,024 | |
| Bldg. 126 Fans | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Bldg. 131 Fans | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 98,112 | |
| Bldg. 129 Fans | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 117,384 | |
| Bldg. 151 Fans | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,795 | |
| Bldg. 154 Fans | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 12,463 | |
| Bldg. 156 Fans | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 10,540 | |
| Bldg. 157 Fans | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 22,914 | |
| Bldg. 159 Fans | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 20,644 | |
| Bldg. 152 Fans | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,967 | |
| Bldg. 155 Fans | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 94,395 | |
| Bldg. 158 Fans | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 48,515 | |
| Bldg. 141 Fans | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 22,342 | |
| Bldg. 260 Fans | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 6,132 | |
| Bldg. 261 Fans | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 6,132 | |
| Bldg. 268 Fans | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 55,188 | |
| Bldg. 142 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 142 HW Pump | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 0 | |
| Bldg. 142 HW Controls | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 0 | |
| Bldg. 123 Unit Heater | | | | | | | | | | | | | | 43 |
| Bldg. 123 Unit Heater Fan | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 403 | |
| Bldg. 126 Boiler | | | | | | | | | | | | | | 94 |
| Bldg. 126 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,379 | |

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 126 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 230 | |
| Bldg. 131 Boiler | | | | | | | | | | | | | | 98 |
| Bldg. 131 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| Bldg. 131 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 131 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| Bldg. 129 Boiler | | | | | | | | | | | | | | 40 |
| Bldg. 129 HW Pump | 2.4 | 2.4 | 2.4 | 2.4 | | | | | | | 2.4 | 2.4 | 10,339 | |
| Bldg. 129 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 151 Resistance Heater | 3.4 | 3.6 | 1.3 | 0.2 | | | | | | | 1.5 | 3.4 | 2,866 | |
| Bldg. 154 Resistance Heater | 5.4 | 5.8 | 3.0 | 0.3 | | | | | | 0.7 | 2.8 | 5.5 | 6,203 | |
| Bldg. 156 Boiler | | | | | | | | | | | | | | 33 |
| Bldg. 156 HW Pump | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 475 | |
| Bldg. 156 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 313 | |
| Bldg. 157 Unit Heater | | | | | | | | | | | | | | 13 |
| Bldg. 157 Unit Heater Fan | 15.0 | 13.0 | 15.0 | 14.0 | | | | | | | 14.0 | 15.0 | 87 | |
| Bldg. 159 Unit Heater | | | | | | | | | | | | | | 0 |
| Bldg. 159 Unit Heater Fan | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 0 | |
| Bldg. 152 Unit Heater | | | | | | | | | | | | | | 89 |
| Bldg. 152 Unit Heater Fan | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 599 | |
| Bldg. 155 Boiler | | | | | | | | | | | | | | 32 |
| Bldg. 155 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| Bldg. 155 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 158 Unit Heater | | | | | | | | | | | | | | 56 |
| Bldg. 158 Unit Heater Fan | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 500 | |
| Bldg. 141 Resistance Heater | 3.7 | 3.7 | 2.1 | 0.2 | | | | | | | 2.1 | 3.7 | 4,295 | |
| Bldgs. 260 & 261 Boiler | | | | | | | | | | | | | | 25 |
| Bldgs. 260 & 261 HW Pump | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | 0.4 | 0.4 | 1,607 | |
| Bldgs. 260 & 261 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldgs. 260 & 261 HW Pump | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | 0.4 | 0.4 | 1,607 | |
| Bldg. 268 Boiler | | | | | | | | | | | | | | 83 |
| Bldg. 268 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| Bldg. 268 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| | | | | | | | | | | | | | | |
| Totals | 420.0 | 419.1 | 425.4 | 418.0 | 1347.5 | 1426.5 | 1500.0 | 1503.7 | 1377.3 | 1177.4 | 424.1 | 420.4 | 4,735,758 | 1,835 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 3,150 | 3,143 | 3,191 | 3,135 | 10,106 | 14,265 | 15,000 | 15,037 | 13,773 | 8,831 | 3,181 | 3,153 | | |

| | | |
|---|---|---|
| Total Demand | 95,964 $/yr | |
| Total Energy | 16,163 MMBTU/yr | (electric) |
| Total Energy | 1,835 MMBTU/yr | (gas) |

| ITEM | ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldgs. 122 & 140 Chiller | | | | | 59.1 | 61.8 | 64.1 | 63.6 | 59.4 | 51.6 | | | 73,523 | |
| Bldgs. 122 & 140 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldgs. 122 & 140 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 122 & 140 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldgs. 124 & 125 Chiller | | | | | 62.4 | 65.7 | 68.5 | 67.9 | 62.8 | 51.7 | | | 79,658 | |
| Bldgs. 124 & 125 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldgs. 124 & 125 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 124 & 125 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldg. 128 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 128 CHW Pump | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 128 CHW Controls | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 133 Chiller | | | | | 37.9 | 43.2 | 44.8 | 44.4 | 41.5 | 36.1 | | | 47,534 | |
| Bldg. 133 CHW Pump | | | | | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | | | 4,946 | |
| Bldg. 133 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 134 & 135 Chiller | | | | | 49.6 | 51.8 | 53.8 | 53.3 | 49.8 | 45.9 | | | 86,869 | |
| Bldgs. 134 & 135 CHW Pump | | | | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | | 1,634 | |
| Bldgs. 134 & 135 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 143 Chiller | | | | | 62.2 | 65.0 | 67.4 | 66.8 | 62.4 | 54.3 | | | 81,071 | |
| Bldg. 143 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldg. 143 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 144 Chiller | | | | | 4.3 | 4.5 | 4.6 | 4.6 | 4.3 | 3.7 | | | 5,181 | |
| Bldg. 144 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 3,356 | |
| Bldg. 144 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 1,498 | |
| Bldg. 144 Chiller | | | | | 56.5 | 59.1 | 61.2 | 60.7 | 56.7 | 49.3 | | | 64,917 | |
| Bldg. 144 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 3,275 | |
| Bldg. 144 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 1,462 | |
| Bldg. 145 Window Units | | | | | 51.9 | 54.0 | 56.0 | 55.5 | 52.0 | 48.6 | | | 36,804 | |
| Bldg. 145 Window Unit Fans | | | | | 4.8 | 5.5 | 7.4 | 7.4 | 5.2 | 3.8 | | | 5,607 | |
| Bldg. 145 Window Unit Controls | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 442 | |
| Bldg. 146 Chiller | | | | | 60.3 | 63.0 | 65.3 | 64.8 | 60.5 | 52.6 | | | 78,227 | |
| Bldg. 146 CHW Pump | | | | | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | | | 4,946 | |
| Bldg. 146 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 147 & 149 Chiller | | | | | 81.0 | 86.4 | 89.6 | 88.9 | 82.6 | 75.1 | | | 128,244 | |
| Bldgs. 147 & 149 CHW Pump | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,472 | |
| Bldgs. 147 & 149 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 197 Chiller | | | | | 59.3 | 62.0 | 64.2 | 63.7 | 59.5 | 51.7 | | | 81,229 | |
| Bldg. 197 CHW Pump | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 6,580 | |
| Bldg. 197 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 198 Condenser | | | | | 13.5 | 14.1 | 14.7 | 14.5 | 13.6 | 11.8 | | | 18,317 | |
| Bldg. 198 Condenser Fans | | | | | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | | | 2,457 | |
| Bldg. 198 CHW Pump | | | | | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | | | 4,946 | |
| Bldg. 198 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 199 Chiller | | | | | 24.8 | 25.9 | 26.9 | 26.7 | 24.9 | 21.6 | | | 32,063 | |
| Bldg. 199 CHW Pump | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 6,580 | |
| Bldg. 199 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 127 Condenser | | | | | 6.6 | 6.9 | 7.1 | 7.1 | 6.6 | 6.1 | | | 8,033 | |
| Bldg. 127 Condenser Fans | | | | | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | | 760 | |
| Bldg. 127 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 250 Chiller | | | | | 142.6 | 149.5 | 161.4 | 164.8 | 143.7 | 125.7 | | | 244,189 | |
| Bldg. 250 CHW Pump | | | | | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | | | 24,730 | |

| ITEM | ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 250 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 122 Fans | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 23,915 | |
| Bldg. 140 Fans | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 2,105 | |
| Bldg. 124 Fans | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 23,924 | |
| Bldg. 125 Fans | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 15.3 | 46,642 | |
| Bldg. 128 Fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 21,675 | |
| Bldg. 133 Fans | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 25,242 | |
| Bldg. 134 Fans | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 51,263 | |
| Bldg. 135 Fans | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 51,263 | |
| Bldg. 143 Fans | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 16.4 | 143,500 | |
| Bldg. 144 Fans | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 52,706 | |
| Bldg. 145 Fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 38,325 | |
| Bldg. 146 Fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 38,325 | |
| Bldg. 147 Fans | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 20,528 | |
| Bldg. 149 Fans | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 15,061 | |
| Bldg. 197 Fans | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 20,800 | |
| Bldg. 198 Fans | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 28,035 | |
| Bldg. 199 Fans | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 6,571 | |
| Bldg. 127 Fans | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 9,563 | |
| Bldg. 250 Fans | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 17,230 | |
| Bldg. 250 Fans | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 34.0 | 173,740 | |
| Bldgs. 122 & 140 Boiler | | | | | | | | | | | | | | 94 |
| Bldgs. 122 & 140 HW Pump | 1.1 | 1.1 | 1.1 | 1.1 | | | | | | | 1.1 | 1.1 | 2,614 | |
| Bldgs. 122 & 140 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 292 | |
| Bldgs. 122 & 140 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 9,557 | |
| Bldgs. 124 & 125 Boiler | | | | | | | | | | | | | | 90 |
| Bldgs. 124 & 125 HW Pump | 1.1 | 1.1 | 1.1 | 1.1 | | | | | | | 1.1 | 1.1 | 2,614 | |
| Bldgs. 124 & 125 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 292 | |
| Bldgs. 124 & 125 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 9,557 | |
| Bldg. 128 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 128 HW Pump | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | 0 | |
| Bldg. 128 HW Controls | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | 0 | |
| Bldg. 133 Boiler | | | | | | | | | | | | | | 84 |
| Bldg. 133 HW Pump | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | 0.4 | 0.4 | 1,607 | |
| Bldg. 133 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 133 Boiler Fan | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 16,203 | |
| Bldgs. 134 & 135 Boiler | | | | | | | | | | | | | | 31 |
| Bldgs. 134 & 135 HW Pump | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | 0.4 | 0.4 | 554 | |
| Bldgs. 134 & 135 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 187 | |
| Bldg. 143 Boiler | | | | | | | | | | | | | | 53 |
| Bldg. 143 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,683 | |
| Bldg. 143 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 281 | |
| Bldg. 144 Boiler | | | | | | | | | | | | | | 53 |
| Bldg. 144 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,683 | |
| Bldg. 144 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 281 | |
| Bldg. 145 Furnace | 21.9 | 21.9 | 21.0 | 1.5 | | | | | | | 19.4 | 21.9 | 6,465 | |
| Bldg. 146 Boiler | | | | | | | | | | | | | | 54 |
| Bldg. 146 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,655 | |
| Bldg. 146 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 276 | |
| Bldg. 147 Boiler | | | | | | | | | | | | | | 47 |

| ITEM | ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 147 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,192 | |
| Bldg. 147 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 199 | |
| Bldg. 149 Boiler | | | | | | | | | | | | | | 47 |
| Bldg. 149 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,192 | |
| Bldg. 149 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 199 | |
| Bldg. 197 Boiler | | | | | | | | | | | | | | 44 |
| Bldg. 197 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 595 | |
| Bldg. 197 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 99 | |
| Bldg. 198 Boiler | | | | | | | | | | | | | | 17 |
| Bldg. 198 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 641 | |
| Bldg. 198 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 143 | |
| Bldg. 199 Boiler | | | | | | | | | | | | | | 45 |
| Bldg. 199 HW Pump | 1.1 | 1.1 | 1.1 | 1.1 | | | | | | | 1.1 | 1.1 | 4,865 | |
| Bldg. 199 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 127 Furnace | | | | | | | | | | | | | | 9 |
| Bldg. 127 Furnace Fan | 0.7 | 0.7 | 0.7 | 0.7 | | | | | | | 0.7 | 0.7 | 3,154 | |
| Bldg. 250 Boiler | | | | | | | | | | | | | | 80 |
| Bldg. 250 Boiler Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 278 | |
| Bldg. 142 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 142 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 142 CHW Pump | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 142 CHW Controls | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 123 Chiller | 9.2 | 9.2 | 9.3 | 11.0 | 12.5 | 13.3 | 14.1 | 14.5 | 13.4 | 10.2 | 9.4 | 9.2 | 38,895 | |
| Bldg. 123 Cooling Tower Fans | 0.1 | 0.0 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0.3 | 6,780 | |
| Bldg. 123 CND Pump | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 10,822 | |
| Bldg. 123 CHW Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 492 | |
| Bldg. 123 Humidifier | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 5,480 | |
| Bldg. 126 Chiller | | | | | 45.1 | 47.2 | 48.9 | 48.5 | 45.3 | 39.4 | | | 57,356 | |
| Bldg. 126 CHW Pump | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 6,580 | |
| Bldg. 126 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 131 Chiller | | | | | 35.5 | 37.1 | 38.5 | 38.2 | 35.7 | 31.0 | | | 48,099 | |
| Bldg. 131 CHW Pump | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | | | 9,892 | |
| Bldg. 131 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 129 Chiller | | | | | 5.6 | 5.8 | 6.0 | 6.0 | 5.6 | 4.9 | | | 15,466 | |
| Bldg. 129 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 129 Chiller | | | | | 42.0 | 43.9 | 45.5 | 45.1 | 42.2 | 37.1 | | | 49,313 | |
| Bldg. 129 CHW Pump | | | | | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | | | 3,477 | |
| Bldg. 129 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 1,461 | |
| Bldg. 151 Window Units | 3.6 | 3.6 | 3.6 | 3.7 | 4.0 | 4.1 | 4.3 | 4.2 | 4.0 | 3.7 | 3.6 | 3.6 | 3,942 | |
| Bldg. 151 Window Unit Fans | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 512 | |
| Bldg. 151 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 233 | |
| Bldg. 154 Window Units | 7.0 | 7.0 | 7.0 | 7.3 | 7.7 | 8.1 | 8.3 | 8.3 | 7.8 | 7.3 | 7.0 | 7.0 | 4,639 | |
| Bldg. 154 Window Unit Fans | 0.1 | 0.0 | 0.2 | 0.4 | 0.5 | 0.6 | 1.0 | 1.0 | 0.6 | 0.3 | 0.2 | 0.1 | 639 | |
| Bldg. 154 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 193 | |
| Bldg. 156 Window Units | 0.0 | 0.0 | 13.1 | 13.8 | 14.6 | 15.2 | 15.8 | 15.7 | 14.7 | 13.7 | 13.1 | 0.0 | 4,352 | |
| Bldg. 156 Window Unit Fans | 0.0 | 0.0 | 0.2 | 0.3 | 0.5 | 0.6 | 1.8 | 1.8 | 0.6 | 0.3 | 0.2 | 0.0 | 631 | |
| Bldg. 156 Window Unit Controls | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 178 | |
| Bldg. 157 Window Units | 3.1 | 3.1 | 3.1 | 3.3 | 3.5 | 3.6 | 3.8 | 3.7 | 3.5 | 3.3 | 3.1 | 3.1 | 4,893 | |
| Bldg. 157 Window Unit Fans | 0.1 | 0.1 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.1 | 683 | |
| Bldg. 157 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 387 | |

| ITEM | ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 159 Condenser | | | | | 3.6 | 3.7 | 3.8 | 3.8 | 3.4 | 2.3 | | | 10,476 | |
| Bldg. 159 Condenser Fans | | | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | | | 1,501 | |
| Bldg. 159 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 152 Window Units | 11.9 | 11.9 | 11.9 | 12.4 | 13.2 | 13.8 | 14.3 | 14.1 | 13.2 | 12.4 | 11.9 | 11.9 | 11,767 | |
| Bldg. 152 Window Unit Fans | 0.3 | 0.3 | 0.8 | 1.2 | 1.6 | 1.8 | 1.9 | 1.9 | 1.8 | 1.2 | 0.8 | 0.4 | 1,769 | |
| Bldg. 152 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 468 | |
| Bldg. 155 Condenser | 7.7 | 8.3 | 7.6 | 7.7 | 8.7 | 9.6 | 9.4 | 9.4 | 8.8 | 7.6 | 7.8 | 8.4 | 15,325 | |
| Bldg. 155 Condenser Fans | 0.4 | 0.4 | 0.5 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 0.9 | 0.8 | 0.7 | 0.5 | 1,439 | |
| Bldg. 155 CHW Pump | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1,412 | |
| Bldg. 155 Condenser Controls | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 757 | |
| Bldg. 155 Window Units | 14.2 | 14.2 | 14.2 | 14.9 | 15.8 | 16.5 | 17.1 | 17.0 | 15.9 | 14.9 | 14.2 | 14.2 | 22,797 | |
| Bldg. 155 Window Unit Fans | 0.6 | 0.6 | 1.1 | 1.7 | 1.8 | 1.8 | 2.0 | 2.0 | 1.8 | 1.7 | 1.1 | 0.7 | 2,660 | |
| Bldg. 155 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 219 | |
| Bldg. 158 Window Units | 9.5 | 9.5 | 9.5 | 9.9 | 10.6 | 11.0 | 11.4 | 11.3 | 10.6 | 9.9 | 9.5 | 9.5 | 12,359 | |
| Bldg. 158 Window Unit Fans | 0.3 | 0.2 | 0.7 | 1.0 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 0.9 | 0.6 | 0.3 | 1,606 | |
| Bldg. 158 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 345 | |
| Bldg. 141 Window Units | 3.1 | 3.1 | 3.1 | 3.3 | 3.5 | 3.6 | 3.8 | 3.7 | 3.5 | 3.3 | 3.1 | 3.1 | 6,489 | |
| Bldg. 141 Window Unit Fans | 0.1 | 0.1 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.1 | 890 | |
| Bldg. 141 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 486 | |
| Bldgs. 260 & 261 Chiller | | | | | 18.3 | 19.9 | 21.1 | 20.9 | 18.3 | 17.3 | | | 24,678 | |
| Bldgs. 260 & 261 CHW Pump | | | | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | | 925 | |
| Bldgs. 260 & 261 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,500 | |
| Bldgs. 260 & 261 CHW Pump | | | | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | | 925 | |
| Bldg. 268 Chiller | 11.3 | 12.3 | 14.0 | 19.0 | 20.9 | 22.8 | 23.6 | 23.4 | 21.9 | 19.0 | 17.5 | 14.2 | 33,891 | |
| Bldg. 268 CHW Pump | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1,365 | |
| Bldg. 268 CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2,437 | |
| Bldg. 142 Fans | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 15,644 | |
| Bldg. 123 Fans | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 21,024 | |
| Bldg. 126 Fans | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 10,942 | |
| Bldg. 131 Fans | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 33,149 | |
| Bldg. 129 Fans | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 13.4 | 40,457 | |
| Bldg. 151 Fans | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,795 | |
| Bldg. 154 Fans | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 12,463 | |
| Bldg. 156 Fans | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 10,540 | |
| Bldg. 157 Fans | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 22,914 | |
| Bldg. 159 Fans | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 20,644 | |
| Bldg. 152 Fans | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,967 | |
| Bldg. 155 Fans | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 31,288 | |
| Bldg. 158 Fans | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 48,515 | |
| Bldg. 141 Fans | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 22,342 | |
| Bldg. 260 Fans | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 6,132 | |
| Bldg. 261 Fans | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 6,132 | |
| Bldg. 268 Fans | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 18,040 | |
| Bldg. 142 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 142 HW Pump | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 0 | |
| Bldg. 142 HW Controls | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 0 | |
| Bldg. 123 Unit Heater | | | | | | | | | | | | | | 46 |
| Bldg. 123 Unit Heater Fan | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 395 | |
| Bldg. 126 Boiler | | | | | | | | | | | | | | 60 |
| Bldg. 126 HW Pump | 0.8 | 0.8 | 0.8 | 0.8 | | | | | | | 0.8 | 0.8 | 1,136 | |

| ITEM | ECO A - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 126 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 189 | |
| Bldg. 131 Boiler | | | | | | | | | | | | | | 55 |
| Bldg. 131 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| Bldg. 131 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 131 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| Bldg. 129 Boiler | | | | | | | | | | | | | | 33 |
| Bldg. 129 HW Pump | 2.4 | 2.4 | 2.4 | 2.4 | | | | | | | 2.4 | 2.4 | 10,339 | |
| Bldg. 129 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 151 Resistance Heater | 4.4 | 4.4 | 0.3 | 0.2 | | | | | | | 3.7 | 4.4 | 2,041 | |
| Bldg. 154 Resistance Heater | 8.7 | 8.9 | 7.7 | 0.3 | | | | | | | 7.7 | 8.9 | 4,218 | |
| Bldg. 156 Boiler | | | | | | | | | | | | | | 22 |
| Bldg. 156 HW Pump | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 390 | |
| Bldg. 156 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 257 | |
| Bldg. 157 Unit Heater | | | | | | | | | | | | | | 9 |
| Bldg. 157 Unit Heater Fan | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 87 | |
| Bldg. 159 Unit Heater | | | | | | | | | | | | | | 0 |
| Bldg. 159 Unit Heater Fan | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | 0.0 | 0.0 | 0 | |
| Bldg. 152 Unit Heater | | | | | | | | | | | | | | 62 |
| Bldg. 152 Unit Heater Fan | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 599 | |
| Bldg. 155 Boiler | | | | | | | | | | | | | | 24 |
| Bldg. 155 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| Bldg. 155 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 158 Unit Heater | | | | | | | | | | | | | | 39 |
| Bldg. 158 Unit Heater Fan | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 453 | |
| Bldg. 141 Resistance Heater | 3.7 | 3.7 | 2.1 | 0.2 | | | | | | | 3.7 | 3.7 | 2,939 | |
| Bldgs. 260 & 261 Boiler | | | | | | | | | | | | | | 17 |
| Bldgs. 260 & 261 HW Pump | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | 0.4 | 0.4 | 1,607 | |
| Bldgs. 260 & 261 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldgs. 260 & 261 HW Pump | 0.4 | 0.4 | 0.4 | 0.4 | | | | | | | 0.4 | 0.4 | 1,607 | |
| Bldg. 268 Boiler | | | | | | | | | | | | | | 29 |
| Bldg. 268 HW Pump | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| Bldg. 268 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 434.3 | 435.8 | 446.3 | 429.6 | 1396.2 | 1452.5 | 1503.5 | 1499.3 | 1408.0 | 1279.4 | 453.6 | 438.6 | 2,998,823 | 1,144 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 3,257 | 3,269 | 3,347 | 3,222 | 10,472 | 14,525 | 15,035 | 14,993 | 14,080 | 9,596 | 3,402 | 3,290 | | |

| | | |
|---|---|---|
| Total Demand | 98,487 $/yr | |
| Demand Savings | -2,523 $/yr | |
| Energy Savings | 5,928 MMBTU/yr | (electric) |
| Energy Savings | 691 MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.06A | DATE: 2/28/96 |
| ECO NO. A AREA 100 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
311,884 Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | HRS/ UNIT | Rate | Total | Unit Price | Total | |
| EMCS COSTS BASED ON DDC ALL ELECTRIC | | | | | | | | |
| DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE | | | | | | | | |
| DIGITAL OUTPUT DEVICE : | | | | | | | | |
| START-STOP MOTOR | 89 | EA | 10.2 | 28.91 | 26,244 | 175.74 | 15,641 | 41,885 |
| ENABLE/DISABLE APPARATUS RELAY | 42 | EA | 4.5 | 28.91 | 5,464 | 49.00 | 2,058 | 7,522 |
| ANALOG OUTPUT: | | | | | | | | |
| CONTROL VALVE (COIL/AHU ACTUATOR ONLY) | 77 | EA | 11.9 | 28.91 | 26,535 | 571.00 | 43,967 | 70,502 |
| DAMPER ACTUATOR & MOTOR | 86 | EA | 11.9 | 28.91 | 29,636 | 340.00 | 29,240 | 58,876 |
| DIGITAL INPUT: | | | | | | | | |
| DIFFERENTIAL PRESSURE SWITCH | 39 | EA | 10.1 | 28.91 | 11,388 | 227.30 | 8,865 | 20,252 |
| AUXILIARY CONTACT | 23 | EA | 4.5 | 28.91 | 2,992 | 49.00 | 1,127 | 4,119 |
| CURRENT SENSING RELAY | 89 | EA | 4.5 | 28.91 | 11,578 | 49.00 | 4,361 | 15,939 |
| SHEET 1 | | | | | | | | |
| | | | | SUBTOTAL | 113,838 | | 105,259 | 219,096 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.06A | DATE: 2/28/96

ECO NO. A AREA 100 | BY : KOTHMANN, K | CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
311,884 Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| ANALOG INPUT: | | | | | | | | |
| TEMP. SENSER & THERMO WELL | 180 | EA | 17.0 | 28.91 | 88,465 | 426.42 | 76,756 | 165,220 |
| TEMP. SENSER AIR DUCT | 78 | EA | 12.0 | 28.91 | 27,060 | 450.00 | 35,100 | 62,160 |
| TEMP. SENSER OUTSIDE AIR | 1 | EA | 12.0 | 28.91 | 347 | 550.00 | 550 | 897 |
| TEMP. SENSER ZONE | 148 | EA | 12.0 | 28.91 | 51,344 | 556.00 | 82,288 | 133,632 |
| RELATIVE HUMIDITY % | 1 | EA | 13.0 | 28.91 | 376 | 615.00 | 615 | 991 |
| GAUGE PRESSURE BOILER | 50 | EA | 8.0 | 28.91 | 11,564 | 197.00 | 9,850 | 21,414 |
| EQUIPMENT FAILURE ALARM | 27 | EA | 2.6 | 28.91 | 2,029 | 108.00 | 2,916 | 4,945 |
| FILTER ALARM | 78 | EA | 4.5 | 28.91 | 10,147 | 227.00 | 17,706 | 27,853 |
| HIGH & LOW LIMIT (HYDRONIC) | 84 | PR | 2.0 | 28.91 | 4,857 | 170.00 | 14,280 | 19,137 |
| SHEET 2 | | | | | | | | |
| | | | | SUBTOTAL | 196,189 | | 240,061 | 436,250 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.06A | DATE: 2/28/96 |
| ECO NO. A AREA 100 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
311,884 Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| OPERATORS' CONSOLE CONTROL UNIT | 1 | SUM | | | | 13,184.00 | 13,184 | 13,184 |
| INCLUDING MODEM & REMOTE PANEL | | | | | | | | |
| SUBMITTALS, TRAINING & START-UP | 1 | JOB | | | | 8,300.00 | 8,300 | 8,300 |
| SOFTWARE | 1 | LS | | | | 15,000.00 | 15,000 | 15,000 |
| SUB TOTAL FROM SHEET 1 | | | | | 113,838 | | 105,259 | 219,096 |
| SUB TOTAL FROM SHEET 2 | | | | | 196,189 | | 240,061 | 436,250 |
| SUBTOTAL | | | | | 310,027 | | 381,803 | 691,830 |
| O & P @ 20% | | | | | 62,005 | | 76,361 | 138,366 |
| SUBTOTAL | | | | | 372,032 | | 458,164 | 830,196 |
| DESIGN @ 6% | | | | | | | | 49,812 |
| SUBTOTAL | | | | | | | | 880,008 |
| SIOH @ 5.5% | | | | | | | | 48,400 |
| TOTAL | | | | | | | | $928,408 |

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Life Cycle Cost Analysis — Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-A
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $830,196 |
| B. SIOH | $48,400 |
| C. Design Cost | $49,812 |
| D. Total Cost (1A+1B+1C) | $928,408 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $928,408 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 5,928 | Mbtus | $37,228 | 15.08 | $561,396 |
| Elec. Deman | | | | | -$2,523 | 14.88 | -$37,542 |
| Natural Gas | $4.4 | /Mbtus | 691 | Mbtus | $3,033 | 18.58 | $56,362 |
| TOTAL | | | 6,619 | Mbtus | $37,738 | | $580,216 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $37,738 |
| 5. Simple Payback Period (Years) | 24.6 |
| 6. Total Net Discounted Savings | $580,216 |
| 7. Savings to Investment Ratio | .62 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | .61% |

ENERGY CONSERVATION OPPORTUNITY (EC0)

| | |
|---|---|
| ECO NO: | B |
| DATE: | 3/1/96 |
| ECO TITLE: | Retrofit Existing Individual Chillers With Central Chiller Plant |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 100 (serving buildings 122, 123, 124, 125, 126, 127, 128, 129, 131,133, 134, 135, 140, 141,142, 143, 144,145, 146, 147, 149, 151, 152, 154, 155, 156, 157, 158, 159, 197, 198, 199, 250, 260, and 261) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 4350 | MMBTU/yr |
| Electrical Demand Savings | 37,558 | $/yr |
| Gas Energy Savings | 0 | MMBTU/yr |
| Total Energy Savings | 4350 | MMBTU/yr |
| Total Cost Savings | 91,649 | $/yr |
| Total Investment | 1,646,927 | $ |
| Simple Payback | 18.0 | yrs |
| SIR | 0.83 | |

B. ECO Description:

Phase 1 - Install a new central cooling plant near Building 250 where the existing 100 ton reciprocating. chiller and an empty concrete pad for future chiller is located. A plant with an approximate 1000 sq ft. or an area large enough to house two centrifugal chillers, two CND and two CHW pumps and their electrical panels will be erected. CHW will be provided through a direct buried 6" primary CHW supply and return piping loop from this plant. This primary CHW loop will split behind Building 155. The first branch will be extended up to Building 198, and the second branch be will be extended up to Building 261. The estimated length of loop will be 6000 ft.. This loop will be served by one new 1175 GPM, 50 HP primary CHW pump at 125 ft. head, and a second new 408 GPM, 20 HP primary pump at 125 ft. Head. All of the existing building CHW pumps will be reutilized as secondary pumps. The chillers to be removed and the secondary pumps to be reutilized are listed in Figure-1. Approximate piping sizes required to connect these pumps with the primary CHW loop are also listed in Figure-1. A new water cooled 480 ton centrifugal R-123 chiller rated at 0.55 KW/ton will be installed. A second 170 ton chiller will be relocated from building 592 along with it's cooling tower and condenser water pump. All new controls and electrical services should be installed at Building 250 to serve the new chillers and pumps. At Building 123 convert the existing CND pump to a secondary CHW pump. Remove the existing cooling tower and 6 water cooled package units. Replace these units with 6 new vertical floor mounted AHUs. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new chiller, cooling tower, associated wiring and controls.

**Figure 1**

| Bldg. # | Quantity | Description | Size | Flow | Estimated Pipe Size | Extimated Pipe Length |
|---|---|---|---|---|---|---|
| | | | Tons | GPM | inches | Feet |
| 122 | 1 | Chiller | 40 | 96 | 2.5 | 60 |
| 123 | 6 | Packaged Units | 30 | 72 | 2 | 70 |
| 124 | 1 | Chiller | 50 | 120 | 3 | 60 |
| 126 | 1 | Chiller | 40 | 96 | 2.5 | 60 |
| 128 | 1 | Chiller | 40 | 96 | 2.5 | 70 |
| 129 | 1 | Chiller | 25 | 60 | 2 | 60 |
| 131 | 1 | Chiller | 29 | 70 | 2 | 60 |
| 133 | 1 | Chiller | 25 | 60 | 2 | 70 |
| 134 | 1 | Chiller | 30 | 72 | 2 | 60 |
| 142 | 1 | Chiller | 10 | 24 | 1.5 | 60 |
| 143 | 1 | Chiller | 45 | 108 | 2.5 | 60 |
| 144 | 1 | Chiller | 45 | 108 | 2.5 | 60 |
| 146 | 1 | Chiller | 40 | 96 | 2.5 | 60 |
| 147 | 1 | Chiller | 50 | 120 | 3 | 75 |
| 155 | 1 | Condensing Unit | 10 | 24 | 1.5 | 60 |
| 197 | 1 | Chiller | 50 | 120 | 3 | 60 |
| 198 | 1 | Chiller | 10 | 24 | 1.5 | 70 |
| 199 | 1 | Chiller | 15 | 36 | 1.5 | 70 |
| 250 | 1 | Chiller | 100 | 240 | 4 | 80 |
| 260 | 1 | Chiller | 15 | 36 | 1.5 | 80 |
| Total | 25 | CHW Equipment | 699 | 1678 | N/A | N/A |

Phase 2 - Buildings with window units and liquid cooled package units will be retrofitted with new air handling units and fan coil units having chilled water coils. New secondary CHW pumps will be installed to serve them. There will be a total of 56 window units and 3 split systems will be removed from the buildings listed in Figure-2. A total of 56 FCUs and 3 AHUs will be installed to replace them. Approx. 200 ft. of 2", 500 ft. of 1.5", 1000 ft. of 1.0" and 2000 ft. of 0.75" piping will be required to feed CHW to these new FCUs and AHUs. Approximately 50 each ½" two way, 6 each ½" three way, 3 each 3/4" two way control valves and 59 electric thermostats will be required. Install 11 new secondary pumps to serve new FCUs and AHUs as indicated in Figure 2.

Currently this ECO includes both Phase I and Phase II. However, if Phase 2 is not implemented, install piping stub outs with cutoff valves on the primary CHW loop for future CHW conversion of the listed buildings in Figure 2.

C. Discussion:

Phase I - This ECO includes all buildings beside building 268. This being the only building in the area that requires year round cooling, it was not cost effective for two reasons. One being the first cost of providing piping to the building which transverses across a street. The second being the operating cost of running a central plant at such low loads for six months out of the year just to serve one building are too high to justify. As listed in Figure-1, most of the other buildings are served by 21 liquid chillers. These chillers generally appear to be in fair to poor condition. Moreover, the cost of maintaining so many chillers is excessive and difficult for the maintenance staff. All of the above chillers are reciprocating air cooled chillers. Generally the chiller efficiency varies between 1.3 KW/ton to 1.8 KW/ton depending on the age and design conditions of the chiller. Therefore it is recommended that a central chiller plant, consisting of two water cooled centrifugal chillers be installed to serve these buildings. Computer simulations of the buildings in this area determined that the current installed capacity of 699 tons is more than required to adequately cool the buildings (Refer to Appendix H for computer modeling simulation). Therefore it is recommended that two new chillers rated at a combined 650 tons to serve the buildings. The 170 ton unit will be operated under a low load condition. Once the load has exceeded the smaller chiller, the second chiller will cycle on while the first chiller cycles off. Finally, once the load rises above the second chiller's capacity, the smaller chiller will cycle on together with the larger chiller. Six existing water cooled package units will be removed from the Museum (Building 123). Six AHUs with chilled water coils and a secondary CHW pump will be installed. The existing CW pump and CW water piping will be reutilized to serve as CHW piping.

Phase 2 - Buildings indicated in Table-2 will be furnished with new FCUs and new secondary CHW pumps. Their sizes are listed in Figure-2. FCUs are selected over the AHUs because of the ease of construction and because of the historical significance of the area. Vertical convector type FCUs can be installed fairly easily in the place of the existing equipment without damaging the antiquity of the buildings. The DX coil split systems will be removed from Buildings 127, 144 and 159, and new horizontal ceiling mounted fan coils will replace the existing AHUs.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed chillers and pumps were calculated using the Trace 600 computer program [1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models [2].

Several types of chillers were modeled including water cooled centrifugal, water cooled centrifugal with VFD drive, water cooled screw, and gas engine driven machines. Full load data was obtained from York International and input into the user defined equipment

associated with Trace 600. Water cooled R-123 centrifugal drives have more efficient full load KW/ton ratings over the screw or gas engine driven machines, while the screw machines were approximately 10% more efficient in the part load range between 25% - 50% full load. These full load performance data from York International was used in the computer simulations of the new chiller energy usage, while part load data was available from equipment supplied with Trace 600. An equipment list of the specific chillers and pumps modeled for the proposed equipment are shown on pageS C-27 through C-30.

The monthly peak demand and energy consumption of the existing and proposed chillers and pumps were calculated using the Trace 600 computer program. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models.

Once the computer simulations of the existing and new chiller plants were completed, the total annual demand cost and energy consumption of the new central plant was compared with that of the existing individual systems to determine the annual savings for this ECO [3]. These savings calculations are shown on pages C-31 through C-34. These demand and energy savings values were used in the life cycle cost analysis. The results of these savings calculations were as follows:

| Alternative | Chiller Type | Demand Savings $/yr | Electrical Savings MMBTU/yr | Gas Savings MMBTU/yr |
|---|---|---|---|---|
| **B1** | Electric Centrifugal | 37,558 | 4350 | 0 |
| **B2** | Electric Centrifugal & VFD | 37,077 | 4495 | 0 |
| **B3** | Electric Screw | 35,298 | 4244 | 0 |
| **B4** | Gas Driven Centrifugal | 50,662 | 5595 | -4022 |

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water cooled chillers, split systems, window units, packaged units, and condensers in this area to two water cooled chillers. The total maintenance cost savings from this ECO is estimated to be $26,773 per year as seen on page C-59. This figure was used in the life cycle cost analysis.

E. Cost Estimates:

The total installation costs for each alternative chiller mentioned in this ECO were estimated on pages C-35 through C-58. These costs were used in the life cycle cost analysis for each alternative. The results of the costs estimates were as follows:

| Alternative | Chiller Type | Estimated Cost |
|---|---|---|
| **B1** | Electric Centrifugal | $1,646,927 |
| **B2** | Electric Centrifugal & VFD | $1,669,966 |
| **B3** | Electric Screw | $1,675,914 |
| **B4** | Gas Driven Centrifugal | $2,009,310 |

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for each life cycle cost analysis is shown on pages C-60 through C-63. The results of the alternative life cycle cost analysis were as follows:

| Alternative | Chiller Type | Payback Years | SIR |
|---|---|---|---|
| **B1** | Electric Centrifugal | 18.0 | 0.83 |
| **B2** | Electric Centrifugal & VFD | 18.1 | 0.82 |
| **B3** | Electric Screw | 18.9 | 0.79 |
| **B4** | Gas Driven Centrifugal | 21.2 | 0.67 |

Since the electric centrifugal chiller has the highest SIR, it is recommended as the most economical choice to replace the existing machine. The data from the life cycle cost analysis for this alternative were included in the summary on page C-22.

## REFERENCES

1. See Appendix B for computer model input assumptions, data, and energy consumption output data.
2. See Appendix C for building field data and existing HVAC system data.
3. See appendix A for utility cost analysis data used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-B1, FORT SAM HOUSTON, AREA 100
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YT<br>water cooled, centrifugal,<br>480 tons, R-123 | Area 100 | New | 264 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>1175 gpm, 125 ft<br>50 HP | Area 100 | New | 37.30 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>1440 gpm, 65 ft<br>40 HP | Area 100 | New | 29.80 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>25 HP fan | Area 100 | New | 18.60 KW |
| Water Chiller | 1 | Trane CVHE 250<br>water cooled, centrifugal,<br>170 tons, R-123 | Currently serves bldg. 592, but relocate to serve Area 100 | 1995 | 105 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>408 gpm, 125 ft<br>20 HP | Area 100 | New | 14.90 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>600 gpm, 65 ft<br>15 HP | Currently serves bldg. 592 Chiller, but relocate to serve Area 100 | 1987 | 11.20 KW |
| Cooling Tower | 1 | Marley<br>single speed, approximately 20 HP | Currently serves bldg. 592 Chiller, but relocate to serve Area 100 | 1988 | 14.90 KW |
| | | | | | |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-B2, FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YT with VFD<br>water cooled, centrifugal,<br>480 tons, R-123 | Area 100 | New | 264 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>1175 gpm, 125 ft<br>50 HP | Area 100 | New | 37.30 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>1440 gpm, 65 ft<br>40 HP | Area 100 | New | 29.80 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>25 HP fan | Area 100 | New | 18.60 KW |
| Water Chiller | 1 | Trane CVHE 250<br>water cooled, centrifugal,<br>170 tons, R-123 | Currently serves bldg. 592, but relocate to serve Area 100 | 1995 | 105 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>408 gpm, 125 ft<br>20 HP | Area 100 | New | 14.90 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>600 gpm, 65 ft<br>15 HP | Currently serves bldg. 592 Chiller, but relocate to serve Area 100 | 1987 | 11.20 KW |
| Cooling Tower | 1 | Marley<br>single speed, approximately 20 HP | Currently serves bldg. 592 Chiller, but relocate to serve Area 100 | 1988 | 14.90 KW |
| | | | | | |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-B3, FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YS<br>water cooled screw<br>480 tons, R-123 | Area 100 | New | 307 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>1175 gpm, 125 ft<br>50 HP | Area 100 | New | 37.30 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>1440 gpm, 65 ft<br>40 HP | Area 100 | New | 29.80 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>25 HP fan | Area 100 | New | 18.60 KW |
| Water Chiller | 1 | Trane CVHE 250<br>water cooled, centrifugal,<br>170 tons, R-123 | Currently serves bldg. 592, but relocate to serve Area 100 | 1995 | 105 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>408 gpm, 125 ft<br>20 HP | Area 100 | New | 14.90 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>600 gpm, 65 ft<br>15 HP | Currently serves bldg. 592 Chiller, but relocate to serve Area 100 | 1987 | 11.20 KW |
| Cooling Tower | 1 | Marley<br>single speed, approximately 20 HP | Currently serves bldg. 592 Chiller, but relocate to serve Area 100 | 1988 | 14.90 KW |
| | | | | | |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-B4, FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York, gas engine driven<br>water cooled, centrifugal<br>480 tons, R-134a | Area 100 | New | 3,168 MBH |
| Chilled Water Pump | 1 | Bell & Gossett<br>1175 gpm, 125 ft<br>50 HP | Area 100 | New | 37.30 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>1584 gpm, 65 ft<br>40 HP | Area 100 | New | 29.80 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>30 HP fan | Area 100 | New | 22.40 KW |
| Water Chiller | 1 | Trane CVHE 250<br>water cooled, centrifugal,<br>170 tons, R-123 | Currently serves bldg. 592, but relocate to serve Area 100 | 1995 | 105 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>408 gpm, 125 ft<br>20 HP | Area 100 | New | 14.90 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>600 gpm, 65 ft<br>15 HP | Currently serves bldg. 592 Chiller, but relocate to serve Area 100 | 1987 | 11.20 KW |
| Cooling Tower | 1 | Marley<br>single speed, approximately 20 HP | Currently serves bldg. 592 Chiller, but relocate to serve Area 100 | 1988 | 14.90 KW |
| | | | | | |
| | | | | | |
| | | | | | |

| ITEM | ECO B - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldgs. 122 & 140 Chiller | | | | | 53.2 | 59.2 | 63.7 | 62.9 | 53.4 | 38.7 | | | 105,589 | |
| Bldgs. 122 & 140 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 124 & 125 Chiller | | | | | 58.7 | 65.2 | 69.7 | 68.4 | 58.3 | 42.8 | | | 114,027 | |
| Bldgs. 124 & 125 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 128 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 128 CHW Controls | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 133 Chiller | | | | | 36.9 | 41.7 | 44.8 | 44.4 | 38.3 | 27.1 | | | 79,446 | |
| Bldg. 133 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 134 & 135 Chiller | | | | | 49.6 | 51.8 | 53.8 | 53.3 | 49.8 | 45.5 | | | 109,087 | |
| Bldgs. 134 & 135 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 143 Chiller | | | | | 56.9 | 61.9 | 66.7 | 67.5 | 58.5 | 45.7 | | | 106,683 | |
| Bldg. 143 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 144 Chiller | | | | | 4.4 | 4.5 | 4.5 | 4.7 | 4.9 | 3.4 | | | 10,120 | |
| Bldg. 144 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,898 | |
| Bldg. 144 Chiller | | | | | 52.3 | 56.8 | 61.2 | 61.9 | 53.7 | 41.9 | | | 83,823 | |
| Bldg. 144 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,657 | |
| Bldg. 145 Window Units | | | | | 51.9 | 54.0 | 56.0 | 55.5 | 52.0 | 48.6 | | | 48,756 | |
| Bldg. 145 Window Unit Fans | | | | | 4.8 | 5.2 | 7.4 | 7.4 | 5.0 | 3.8 | | | 7,225 | |
| Bldg. 145 Window Unit Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 442 | |
| Bldg. 146 Chiller | | | | | 54.7 | 59.5 | 64.2 | 64.9 | 56.2 | 44.1 | | | 106,939 | |
| Bldg. 146 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldgs. 147 & 149 Chiller | | | | | 81.0 | 86.4 | 89.6 | 88.9 | 82.6 | 70.8 | | | 176,040 | |
| Bldgs. 147 & 149 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 197 Chiller | | | | | 56.1 | 61.1 | 65.6 | 65.9 | 57.7 | 45.7 | | | 106,257 | |
| Bldg. 197 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 198 Condenser | | | | | 13.2 | 14.1 | 14.7 | 14.5 | 13.6 | 10.1 | | | 20,362 | |
| Bldg. 198 Condenser Fans | | | | | 1.7 | 1.8 | 1.8 | 1.8 | 1.8 | 1.4 | | | 2,731 | |
| Bldg. 198 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 199 Chiller | | | | | 21.6 | 24.1 | 26.4 | 26.6 | 22.7 | 16.4 | | | 46,260 | |
| Bldg. 199 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 127 Condenser | | | | | 6.6 | 6.9 | 7.1 | 7.1 | 6.6 | 6.1 | | | 10,166 | |
| Bldg. 127 Condenser Fans | | | | | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | | | 956 | |
| Bldg. 127 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 250 Chiller | | | | | 140.8 | 150.4 | 162.3 | 166.0 | 145.0 | 110.5 | | | 315,629 | |
| Bldg. 250 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 142 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 142 Chiller | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 142 CHW Controls | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 0 | |
| Bldg. 123 Chiller | | | | | 13.1 | 13.3 | 14.1 | 14.5 | 13.4 | 10.2 | | | 34,487 | |
| Bldg. 123 Cooling Tower Fans | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 5,893 | |
| Bldg. 123 CHW Controls | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 413 | |
| Bldg. 126 Chiller | | | | | 40.4 | 43.8 | 47.1 | 47.9 | 43.3 | 35.0 | | | 86,201 | |
| Bldg. 126 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 131 Chiller | | | | | 32.7 | 35.7 | 38.3 | 38.2 | 35.4 | 27.8 | | | 69,516 | |
| Bldg. 131 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 129 Chiller | | | | | 4.9 | 5.2 | 5.7 | 5.9 | 5.6 | 4.9 | | | 13,350 | |
| Bldg. 129 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 129 Chiller | | | | | 36.7 | 39.3 | 42.8 | 44.3 | 42.0 | 37.1 | | | 72,266 | |
| Bldg. 129 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,305 | |
| Bldg. 151 Window Units | 3.6 | 3.6 | 3.6 | 3.7 | 4.0 | 4.1 | 4.3 | 4.2 | 4.0 | 4 | 4 | 3.6 | 5,685 | |

| ITEM | ECO B - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 151 Window Unit Fans | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 733 | |
| Bldg. 151 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 434 | |
| Bldg. 154 Window Units | 7.0 | 7.0 | 7.0 | 7.3 | 7.7 | 8.1 | 8.3 | 8.3 | 7.8 | 7.3 | 7.0 | 7.0 | 7,197 | |
| Bldg. 154 Window Unit Fans | 0.1 | 0.0 | 0.2 | 0.4 | 0.5 | 0.6 | 1.0 | 1.0 | 0.6 | 0.3 | 0.2 | 0.1 | 978 | |
| Bldg. 154 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 379 | |
| Bldg. 156 Window Units | 0.0 | 0.0 | 13.1 | 13.8 | 14.6 | 15.2 | 15.8 | 15.7 | 14.7 | 13.7 | 13.1 | 0.0 | 7,055 | |
| Bldg. 156 Window Unit Fans | 0.0 | 0.0 | 0.2 | 0.3 | 0.5 | 0.5 | 1.8 | 1.8 | 0.5 | 0.3 | 0.2 | 0.0 | 986 | |
| Bldg. 156 Window Unit Controls | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 358 | |
| Bldg. 157 Window Units | 3.1 | 3.1 | 3.1 | 3.3 | 3.5 | 3.6 | 3.8 | 3.7 | 3.5 | 3.3 | 3.1 | 3.1 | 6,357 | |
| Bldg. 157 Window Unit Fans | 0.1 | 0.1 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.1 | 876 | |
| Bldg. 157 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 514 | |
| Bldg. 159 Condenser | | | | | 3.6 | 3.7 | 3.8 | 3.8 | 3.4 | 2.3 | | | 10,476 | |
| Bldg. 159 Condenser Fans | | | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | | | 1,501 | |
| Bldg. 159 Condenser Controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 1,325 | |
| Bldg. 152 Window Units | 11.9 | 11.9 | 11.9 | 12.4 | 13.2 | 13.8 | 14.3 | 14.1 | 13.2 | 12.4 | 11.9 | 11.9 | 18,405 | |
| Bldg. 152 Window Unit Fans | 0.3 | 0.3 | 0.8 | 1.2 | 1.6 | 1.8 | 1.9 | 1.9 | 1.7 | 1.2 | 0.8 | 0.4 | 2,716 | |
| Bldg. 152 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 484 | |
| Bldg. 155 Condenser | 8.2 | 8.3 | 6.6 | 6.4 | 8.1 | 10.0 | 9.9 | 9.3 | 9.0 | 7.8 | 7.8 | 8.3 | 22,335 | |
| Bldg. 155 Condenser Fans | 0.6 | 0.4 | 0.7 | 0.7 | 0.8 | 1.0 | 1.0 | 1.0 | 0.9 | 0.8 | 0.7 | 0.5 | 2,305 | |
| Bldg. 155 Condenser Controls | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 1,457 | |
| Bldg. 155 Window Units | 14.2 | 14.2 | 14.2 | 14.9 | 15.8 | 16.5 | 17.1 | 17.0 | 15.9 | 14.9 | 14.2 | 14.2 | 16,295 | |
| Bldg. 155 Window Unit Fans | 0.6 | 0.5 | 1.1 | 1.4 | 1.6 | 1.7 | 2.0 | 2.0 | 1.7 | 1.3 | 1.1 | 0.6 | 2,065 | |
| Bldg. 155 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 193 | |
| Bldg. 158 Window Units | 9.5 | 9.5 | 9.5 | 9.9 | 10.6 | 11.0 | 11.4 | 11.3 | 10.6 | 9.9 | 9.5 | 9.5 | 17,371 | |
| Bldg. 158 Window Unit Fans | 0.3 | 0.2 | 0.7 | 1.0 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 0.9 | 0.6 | 0.3 | 2,214 | |
| Bldg. 158 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 450 | |
| Bldg. 141 Window Units | 3.1 | 3.1 | 3.1 | 3.3 | 3.5 | 3.6 | 3.8 | 3.7 | 3.5 | 3.3 | 3.1 | 3.1 | 8,248 | |
| Bldg. 141 Window Unit Fans | 0.1 | 0.1 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.1 | 1,133 | |
| Bldg. 141 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 512 | |
| Bldgs. 260 & 261 Chiller | | | | | 18.3 | 19.9 | 21.1 | 20.9 | 18.3 | 14.6 | | | 35,084 | |
| Bldgs. 260 & 261 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,906 | |
| Bldg. 268 Chiller | 11.3 | 11.3 | 13.3 | 15.9 | 19.2 | 21.3 | 22.9 | 23.2 | 20.0 | 14.8 | 12.9 | 11.3 | 48,278 | |
| Bldg. 268 CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 5,323 | |
| | | | | | | | | | | | | | | |
| Totals | 76.1 | 75.7 | 92.0 | 99.1 | 1025.7 | 1104.7 | 1178.2 | 1181.9 | 1055.5 | 854.9 | 92.7 | 76.2 | 2,036,210 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 571 | 568 | 690 | 743 | 7,693 | 11,047 | 11,782 | 11,819 | 10,555 | 6,412 | 695 | 572 | | |

| | | | |
|---|---|---|---|
| Total Demand | 63,146 | $/yr | |
| Total Energy | 6,950 | MMBTU/yr | (electric) |
| Total Energy | | MMBTU/yr | (gas) |

| ITEM | ECO-B1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (170 TON) | | | | | 92.3 | 98.7 | 97.2 | 102.2 | 91.0 | 85.4 | | | 102,000 | |
| Cooling Tower | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 27,588 | |
| CHW Pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 32,303 | |
| CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 24,282 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,168 | |
| Water Chiller (480 TON) | | | | | 233.2 | 249.9 | 245.0 | 257.1 | 245.0 | 208.9 | | | 367,084 | |
| Cooling Tower | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 44,249 | |
| CHW Pump | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 88,737 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 70,894 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,379 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 454.2 | 477.3 | 470.9 | 488.0 | 464.7 | 423.0 | | | 761,684 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | | | | | 3,407 | 4,773 | 4,709 | 4,880 | 4,647 | 3,173 | | | | |

Total Demand 25,588 $/yr
Demand Savings 37,558 $/yr
Energy Savings 4,350 MMBTU/yr (electric)
Energy Savings MMBTU/yr (gas)

| ITEM | ECO-B2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (170 TON) | | | | | 92.3 | 98.7 | 97.2 | 102.2 | 91.0 | 85.4 | | | 102,000 | |
| Cooling Tower | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 27,588 | |
| CHW Pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 32,303 | |
| CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 24,282 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,168 | |
| Water Chiller (480 TON) | | | | | 264.0 | 263.9 | 252.5 | 256.3 | 253.6 | 234.0 | | | 351,164 | |
| Cooling Tower | | | | | 12.1 | 13.5 | 16.5 | 18.6 | 14.4 | 9.5 | | | 17,581 | |
| CHW Pump | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 88,737 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 70,894 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,379 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 478.5 | 486.2 | 476.3 | 487.2 | 469.1 | 439.0 | | | 719,096 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | | | | | 3,589 | 4,862 | 4,763 | 4,872 | 4,691 | 3,293 | | | | |

Total Demand 26,069 $/yr
Demand Savings 37,077 $/yr
Energy Savings 4,495 MMBTU/yr (electric)
Energy Savings MMBTU/yr (gas)

| ITEM | ECO-B3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (170 TON) | | | | | 92.3 | 98.7 | 97.2 | 102.2 | 91.0 | 85.4 | | | 102,000 | |
| Cooling Tower | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 27,588 | |
| CHW Pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 32,303 | |
| CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 24,282 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,168 | |
| Water Chiller (480 TON) | | | | | 274.1 | 292.0 | 286.2 | 299.1 | 286.2 | 247.3 | | | 397,991 | |
| Cooling Tower | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 44,249 | |
| CHW Pump | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 88,737 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 70,894 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,379 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 495.1 | 519.4 | 512.1 | 530.0 | 505.9 | 461.4 | | | 792,591 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | | | | | 3,713 | 5,194 | 5,121 | 5,300 | 5,059 | 3,461 | | | | |

Total Demand 27,848 $/yr

Demand Savings 35,298 $/yr

Energy Savings 4,244 MMBTU/yr (electric)

Energy Savings MMBTU/yr (gas)

| ITEM | ECO-B4: NEW GAS ENGINE DRIVEN CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (170 TON) | | | | | 92.3 | 98.7 | 95.8 | 99.8 | 91.0 | 85.4 | | | 94,971 | |
| Cooling Tower | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 27,588 | |
| CHW Pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 32,303 | |
| CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 24,282 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,168 | |
| Water Chiller (480 TON) | | | | | | | | | | | | | | 4,022 |
| Cooling Tower | | | | | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | | | 53,290 | |
| CHW Pump | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 88,737 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 70,894 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,379 | |
| Heater for 480 ton chiller | | | | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | | | 307 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 225.0 | 231.4 | 228.5 | 232.5 | 223.7 | 218.1 | | | 396,919 | 4,022 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | | | | | 1,688 | 2,314 | 2,285 | 2,325 | 2,237 | 1,636 | | | | |

Total Demand 12,484 $/yr

Demand Savings 50,662 $/yr

Energy Savings 5,595 MMBTU/yr (electric)

Energy Savings -4,022 MMBTU/yr (gas)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-0185.6B1 **DATE:** 3/2/96

**ECO NO. B-1** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER UP TO 100 TON | 100 | TON | 1.5 | 28.91 | 4,452 | 25.00 | 2,500 | 6,952 |
| RMV CHILLER UP TO 50 TON | 614 | TON | 1.6 | 28.91 | 28,579 | 25.00 | 15,350 | 43,929 |
| RMV WTR COOLED PACKAGE UNIT AND FLUID COOLER | 6 | EA | 8.9 | 28.91 | 1,544 | 50.00 | 300 | 1,844 |
| RMV DIRECT EXPANSION CONDENSER & AHU | 2 | EA | 5.0 | 28.91 | 289 | 50.00 | 100 | 389 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 6,000 | LF | 1.0 | 28.91 | 180,398 | 29.50 | 177,000 | 357,398 |
| 4" | 160 | LF | 0.8 | 28.91 | 3,469 | 19.55 | 3,128 | 6,597 |
| 3" | 400 | LF | 0.6 | 28.91 | 6,938 | 15.70 | 6,280 | 13,218 |
| 2-1/2" | 1,340 | LF | 0.5 | 28.91 | 18,595 | 13.33 | 17,862 | 36,457 |
| 2" | 640 | LF | 0.4 | 28.91 | 7,401 | 13.55 | 8,672 | 16,073 |
| 1-1/2" | 680 | LF | 0.4 | 28.91 | 7,077 | 12.85 | 8,738 | 15,815 |
| | | | | | | | | |
| | | | | SUBTOTAL | 258,743 | | 239,930 | 498,673 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6B1 | **DATE:** 3/2/96

**ECO NO. B-1** Retrofit Existing Individual Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 6" | 8 | EA | 2.1 | 28.91 | 481 | 590.00 | 4,720 | 5,201 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 500.0 | 20.00 | 10,000 | 9,000.00 | 9,000 | 19,000 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 3 | LOC | 10.7 | 28.91 | 924 | 717.00 | 2,151 | 3,075 |
| 2-1/2" | 7 | LOC | 9.6 | 28.91 | 1,943 | 639.00 | 4,473 | 6,416 |
| 2" | 5 | LOC | 9.6 | 28.91 | 1,388 | 639.00 | 3,195 | 4,583 |
| 1-1/2" | 5 | LOC | 8.0 | 28.91 | 1,156 | 600.00 | 3,000 | 4,156 |
| ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE, | | | | | | | | |
| PIPING ASSEMBLY & ELECTRICAL | | | | | | | | |
| VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY | 6 | EA | 10.0 | 28.91 | 1,735 | 3,900.00 | 23,400 | 25,135 |
| AHU W/ CHW COIL 2-PIPE 2000 CFM | 2 | EA | 14.5 | 28.91 | 838 | 3,400.00 | 6,800 | 7,638 |
| | | | | SUBTOTAL | 18,916 | | 57,774 | 76,690 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6B1
**DATE:** 3/2/96

**ECO NO. B-1** Retrofit Existing Individual Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| CONSTRUCT CENTRAL PLANT BASE BUILDING | 1,000 | BSF | | | | 75.00 | 75,000 | 75,000 |
| HISTORICLY COMPATABLE | | | | | | | | |
| COOLING TOWER ENCLOSURE | 1 | SUM | 1.0 | 9,000.00 | 9,000 | 12,000.00 | 12,000 | 21,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 1,000 | BSF | | | | 34.00 | 34,000 | 34,000 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 480 | TON | 3.2 | 28.91 | 44,406 | 371.00 | 178,080 | 222,486 |
| RELOCATE CHILLER FROM BLDG 592 | 170 | TON | 4.7 | 28.91 | 23,099 | 75.00 | 12,750 | 35,849 |
| PRIMARY PUMPS 50 HP | 1 | EA | 100.0 | 28.91 | 2,891 | 8,200.00 | 8,200 | 11,091 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 500 | TON | 0.6 | 28.91 | 8,673 | 92.00 | 46,000 | 54,673 |
| RELOCATE COOLING TOWER AND PUMPS FROM BLDG 592 | 170 | TON | 1.2 | 28.91 | 5,898 | 35.00 | 5,950 | 11,848 |
| | | | | SUBTOTAL | 93,966 | | 371,980 | 465,946 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. B-1 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6B1

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED | 59 | EA | 1.5 | 22.00 | 1,947 | 10.00 | 590 | 2,537 |
| REMOVE PACKAGE UNIT 4 TON | 1 | EA | 8.9 | 28.91 | 257 | 25.00 | 25 | 282 |
| REMOVE SPLIT SYSTEM 3-4 TON EQUIPMENT | 2 | EA | 10.0 | 28.91 | 578 | 50.00 | 100 | 678 |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 3" | 100 | LF | 0.6 | 28.91 | 1,735 | 15.70 | 1,570 | 3,305 |
| 2" | 100 | LF | 0.4 | 28.91 | 1,156 | 13.35 | 1,335 | 2,491 |
| 1-1/2" | 240 | LF | 0.4 | 28.91 | 2,498 | 12.85 | 3,084 | 5,582 |
| 1-1/4" | 320 | LF | 0.4 | 28.91 | 3,238 | 11.90 | 3,808 | 7,046 |
| 1" | 100 | LF | 0.3 | 28.91 | 925 | 10.65 | 1,065 | 1,990 |
| | | | | SUBTOTAL | 12,334 | | 11,577 | 23,911 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6B1 | | DATE: 3/2/96 |
| ECO NO. B-1 Retrofit Existing Individual Chillers | BY : KOTHMANN, K | | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 5 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND NEW CHW PUMPS COST PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 21.2 | 28.91 | 613 | 2,417.00 | 2,417 | 3,030 |
| 2" | 1 | LOC | 19.2 | 28.91 | 555 | 1,639.00 | 1,639 | 2,194 |
| 1-1/2" | 3 | LOC | 16.0 | 28.91 | 1,388 | 1,400.00 | 4,200 | 5,588 |
| 1-1/4" | 4 | LOC | 16.0 | 28.91 | 1,850 | 1,400.00 | 5,600 | 7,450 |
| 1" | 2 | LOC | 14.0 | 28.91 | 809 | 1,300.00 | 2,600 | 3,409 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 200 | EA | 0.5 | 28.91 | 2,891 | 7.05 | 1,410 | 4,301 |
| 1-1/2" | 500 | EA | 0.4 | 28.91 | 5,782 | 5.05 | 2,525 | 8,307 |
| 1" | 1,000 | EA | 0.3 | 28.91 | 8,673 | 4.38 | 4,380 | 13,053 |
| 3/4" | 2,000 | EA | 0.3 | 28.91 | 17,346 | 2.75 | 5,500 | 22,846 |
| | | | | SUBTOTAL | 39,907 | | 30,271 | 70,178 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. B-1 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6B1

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, | 56 | EA | 4.8 | 28.91 | 7,690 | 1,375.00 | 77,000 | 84,690 |
| CONTROL VALVE AND ELECTRIC CIRCUIT | | | | | | | | |
| AHU 2-PIPE W/ COIL, PIPING AND CONTROL VALVE | | | | | | | | |
| 4,5 TON | 1 | EA | 14.5 | 28.91 | 419 | 3,400.00 | 3,400 | 3,819 |
| 3 TON | 1 | EA | 12.0 | 28.91 | 347 | 3,000.00 | 3,000 | 3,347 |
| SUB TOTAL FROM SHEET 1 | | | | | 258,743 | | 239,930 | 498,673 |
| SUB TOTAL FROM SHEET 2 | | | | | 18,916 | | 57,774 | 76,690 |
| SUB TOTAL FROM SHEET 3 | | | | | 93,966 | | 371,980 | 465,946 |
| SUB TOTAL FROM SHEET 4 | | | | | 12,334 | | 11,577 | 23,911 |
| SUB TOTAL FROM SHEET 5 | | | | | 39,907 | | 30,271 | 70,178 |
| SUBTOTAL | | | | | 432,323 | | 794,932 | 1,227,255 |
| O & P @ 20% | | | | | 86,465 | | 158,986 | 245,451 |
| SUBTOTAL | | | | | 518,787 | | 953,919 | 1,472,706 |
| DESIGN @ 6% | | | | | | | | 88,362 |
| SUBTOTAL | | | | | | | | 1,561,068 |
| SIOH @ 5.5% | | | | | | | | 85,859 |
| TOTAL | | | | | | | | $1,646,927 |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6B2 | **DATE:** 3/2/96

**ECO NO. B- 2** Retrofit Existing Individual Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE ONE250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| SHEET 1 | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER UP TO 100 TON | 100 | TON | 1.5 | 28.91 | 4,452 | 25.00 | 2,500 | 6,952 |
| RMV CHILLER UP TO 50 TON | 614 | TON | 1.6 | 28.91 | 28,579 | 25.00 | 15,350 | 43,929 |
| RMV WTR COOLED PACKAGE UNIT AND FLUID COOLER | 6 | EA | 8.9 | 28.91 | 1,544 | 50.00 | 300 | 1,844 |
| RMV DIRECT EXPANSION CONDENSER & AHU | 2 | EA | 5.0 | 28.91 | 289 | 50.00 | 100 | 389 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 6,000 | LF | 1.0 | 28.91 | 180,398 | 29.50 | 177,000 | 357,398 |
| 4" | 160 | LF | 0.8 | 28.91 | 3,469 | 19.55 | 3,128 | 6,597 |
| 3" | 400 | LF | 0.6 | 28.91 | 6,938 | 15.70 | 6,280 | 13,218 |
| 2-1/2" | 1,340 | LF | 0.5 | 28.91 | 18,595 | 13.33 | 17,862 | 36,457 |
| 2" | 640 | LF | 0.4 | 28.91 | 7,401 | 13.55 | 8,672 | 16,073 |
| 1-1/2" | 680 | LF | 0.4 | 28.91 | 7,077 | 12.85 | 8,738 | 15,815 |
| | | | | | | | | |
| | | | | SUBTOTAL | 258,743 | | 239,930 | 498,673 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6B2 **DATE:** 3/2/96

**ECO NO. B** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 6" | 8 | EA | 2.1 | 28.91 | 481 | 590.00 | 4,720 | 5,201 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 500.0 | 20.00 | 10,000 | 9,000.00 | 9,000 | 19,000 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 3 | LOC | 10.7 | 28.91 | 924 | 717.00 | 2,151 | 3,075 |
| 2-1/2" | 7 | LOC | 9.6 | 28.91 | 1,943 | 639.00 | 4,473 | 6,416 |
| 2" | 5 | LOC | 9.6 | 28.91 | 1,388 | 639.00 | 3,195 | 4,583 |
| 1-1/2" | 5 | LOC | 8.0 | 28.91 | 1,156 | 600.00 | 3,000 | 4,156 |
| ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE, | | | | | | | | |
| PIPING ASSEMBLY & ELECTRICAL | | | | | | | | |
| VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY | 6 | EA | 10.0 | 28.91 | 1,735 | 3,900.00 | 23,400 | 25,135 |
| AHU W/ CHW COIL 2-PIPE 2000 CFM | 2 | EA | 14.5 | 28.91 | 838 | 3,400.00 | 6,800 | 7,638 |
| | | | | SUBTOTAL | 18,916 | | 57,774 | 76,690 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6B2

**DATE:** 3/2/96

**ECO NO.** B-2 **Retrofit Existing Individual Chillers**

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE ONE 250923Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| CONSTRUCT CENTRAL PLANT BASE BUILDING | 1,000 | BSF | | | | 75.00 | 75,000 | 75,000 |
| HISTORICLY COMPATABLE | | | | | | | | |
| COOLING TOWER ENCLOSURE | 1 | SUM | 1.0 | 9,000.00 | 9,000 | 12,000.00 | 12,000 | 21,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 1,000 | BSF | | | | 34.00 | 34,000 | 34,000 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 480 | TON | 3.2 | 28.91 | 44,406 | 371.00 | 178,080 | 222,486 |
| RELOCATE CHILLER FROM BLDG 592 | 170 | TON | 4.7 | 28.91 | 23,099 | 75.00 | 12,750 | 35,849 |
| PRIMARY PUMPS 50 HP | 1 | EA | 100.0 | 28.91 | 2,891 | 8,200.00 | 8,200 | 11,091 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 500 | TON | 0.6 | 28.91 | 8,673 | 92.00 | 46,000 | 54,673 |
| RELOCATE COOLING TOWER AND PUMPS FROM BLDG 592 | 170 | TON | 1.2 | 28.91 | 5,898 | 35.00 | 5,950 | 11,848 |
| ADD FOR VFD AT PRIMARY CHILLER | 100 | HP | 0.8 | 28.91 | 2,168 | 150.00 | 15,000 | 17,168 |
| | | | | SUBTOTAL | 96,135 | | 386,980 | 483,115 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. B** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6B2 **DATE:** 3/2/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE TWO 52497 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED | 59 | EA | 1.5 | 22.00 | 1,947 | 10.00 | 590 | 2,537 |
| REMOVE PACKAGE UNIT 4 TON | 1 | EA | 8.9 | 28.91 | 257 | 25.00 | 25 | 282 |
| REMOVE SPLIT SYSTEM 3-4 TON EQUIPMENT | 2 | EA | 10.0 | 28.91 | 578 | 50.00 | 100 | 678 |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 3" | 100 | LF | 0.6 | 28.91 | 1,735 | 15.70 | 1,570 | 3,305 |
| 2" | 100 | LF | 0.4 | 28.91 | 1,156 | 13.35 | 1,335 | 2,491 |
| 1-1/2" | 240 | LF | 0.4 | 28.91 | 2,498 | 12.85 | 3,084 | 5,582 |
| 1-1/4" | 320 | LF | 0.4 | 28.91 | 3,238 | 11.90 | 3,808 | 7,046 |
| 1" | 100 | LF | 0.3 | 28.91 | 925 | 10.65 | 1,065 | 1,990 |
| | | | | SUBTOTAL | 12,334 | | 11,577 | 23,911 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6B2

**DATE:** 3/2/96

**ECO NO. B** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE TWO 52497 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 5 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND NEW CHW PUMPS COST PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 21.2 | 28.91 | 613 | 2,417.00 | 2,417 | 3,030 |
| 2" | 1 | LOC | 19.2 | 28.91 | 555 | 1,639.00 | 1,639 | 2,194 |
| 1-1/2" | 3 | LOC | 16.0 | 28.91 | 1,388 | 1,400.00 | 4,200 | 5,588 |
| 1-1/4" | 4 | LOC | 16.0 | 28.91 | 1,850 | 1,400.00 | 5,600 | 7,450 |
| 1" | 2 | LOC | 14.0 | 28.91 | 809 | 1,300.00 | 2,600 | 3,409 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 200 | EA | 0.5 | 28.91 | 2,891 | 7.05 | 1,410 | 4,301 |
| 1-1/2" | 500 | EA | 0.4 | 28.91 | 5,782 | 5.05 | 2,525 | 8,307 |
| 1" | 1,000 | EA | 0.3 | 28.91 | 8,673 | 4.38 | 4,380 | 13,053 |
| 3/4" | 2,000 | EA | 0.3 | 28.91 | 17,346 | 2.75 | 5,500 | 22,846 |
| | | | | SUBTOTAL | 39,907 | | 30,271 | 70,178 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6B2

**DATE:** 3/2/96

**ECO NO. B** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
PHASE TWO 52497 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, | 56 | EA | 4.8 | 28.91 | 7,690 | 1,375.00 | 77,000 | 84,690 |
| CONTROL VALVE AND ELECTRIC CIRCUIT | | | | | | | | |
| AHU 2-PIPE W/ COIL, PIPING AND CONTROL VALVE | | | | | | | | |
| 4,5 TON | 1 | EA | 14.5 | 28.91 | 419 | 3,400.00 | 3,400 | 3,819 |
| 3 TON | 1 | EA | 12.0 | 28.91 | 347 | 3,000.00 | 3,000 | 3,347 |
| SUB TOTAL FROM SHEET 1 | | | | | 258,743 | | 239,930 | 498,673 |
| SUB TOTAL FROM SHEET 2 | | | | | 18,916 | | 57,774 | 76,690 |
| SUB TOTAL FROM SHEET 3 | | | | | 96,135 | | 386,980 | 483,115 |
| SUB TOTAL FROM SHEET 4 | | | | | 12,334 | | 11,577 | 23,911 |
| SUB TOTAL FROM SHEET 5 | | | | | 39,907 | | 30,271 | 70,178 |
| | | | | SUBTOTAL | 434,491 | | 809,932 | 1,244,423 |
| | | | | O & P @ 20% | 86,898 | | 161,986 | 248,885 |
| | | | | SUBTOTAL | 521,389 | | 971,919 | 1,493,308 |
| | | | | DESIGN @ 6% | | | | 89,598 |
| | | | | SUBTOTAL | | | | 1,582,906 |
| | | | | SIOH @ 5.5% | | | | 87,060 |
| | | | | TOTAL | | | | $1,669,966 |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.6B3 | | DATE: 3/2/96 |
| ECO NO. B-3 Retrofit Existing Individual Chillers | BY : KOTHMANN, K | | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 1 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER UP TO 100 TON | 100 | TON | 1.5 | 28.91 | 4,452 | 25.00 | 2,500 | 6,952 |
| RMV CHILLER UP TO 50 TON | 614 | TON | 1.6 | 28.91 | 28,579 | 25.00 | 15,350 | 43,929 |
| RMV WTR COOLED PACKAGE UNIT AND FLUID COOLER | 6 | EA | 8.9 | 28.91 | 1,544 | 50.00 | 300 | 1,844 |
| RMV DIRECT EXPANSION CONDENSER & AHU | 2 | EA | 5.0 | 28.91 | 289 | 50.00 | 100 | 389 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 6,000 | LF | 1.0 | 28.91 | 180,398 | 29.50 | 177,000 | 357,398 |
| 4" | 160 | LF | 0.8 | 28.91 | 3,469 | 19.55 | 3,128 | 6,597 |
| 3" | 400 | LF | 0.6 | 28.91 | 6,938 | 15.70 | 6,280 | 13,218 |
| 2-1/2" | 1,340 | LF | 0.5 | 28.91 | 18,595 | 13.33 | 17,862 | 36,457 |
| 2" | 640 | LF | 0.4 | 28.91 | 7,401 | 13.55 | 8,672 | 16,073 |
| 1-1/2" | 680 | LF | 0.4 | 28.91 | 7,077 | 12.85 | 8,738 | 15,815 |
| | | | | SUBTOTAL | 258,743 | | 239,930 | 498,673 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. B-3** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6B3 **DATE:** 3/2/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 6" | 8 | EA | 2.1 | 28.91 | 481 | 590.00 | 4,720 | 5,201 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 500.0 | 20.00 | 10,000 | 9,000.00 | 9,000 | 19,000 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 3 | LOC | 10.7 | 28.91 | 924 | 717.00 | 2,151 | 3,075 |
| 2-1/2" | 7 | LOC | 9.6 | 28.91 | 1,943 | 639.00 | 4,473 | 6,416 |
| 2" | 5 | LOC | 9.6 | 28.91 | 1,388 | 639.00 | 3,195 | 4,583 |
| 1-1/2" | 5 | LOC | 8.0 | 28.91 | 1,156 | 600.00 | 3,000 | 4,156 |
| ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE, | | | | | | | | |
| PIPING ASSEMBLY & ELECTRICAL | | | | | | | | |
| VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY | 6 | EA | 10.0 | 28.91 | 1,735 | 3,900.00 | 23,400 | 25,135 |
| AHU W/ CHW COIL 2-PIPE 2000 CFM | 2 | EA | 14.5 | 28.91 | 838 | 3,400.00 | 6,800 | 7,638 |
| | | | | SUBTOTAL | 18,916 | | 57,774 | 76,690 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. B-3 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6B3

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| CONSTRUCT CENTRAL PLANT BASE BUILDING | 1,000 | BSF | | | | 75.00 | 75,000 | 75,000 |
| HISTORICLY COMPATABLE | | | | | | | | |
| COOLING TOWER ENCLOSURE | 1 | SUM | 1.0 | 9,000.00 | 9,000 | 12,000.00 | 12,000 | 21,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 1,000 | BSF | | | | 34.00 | 34,000 | 34,000 |
| CHILLER (YORK YS) WITH PIPING & VESELS | 480 | TON | 3.2 | 28.91 | 44,406 | 416.00 | 199,680 | 244,086 |
| RELOCATE CHILLER FROM BLDG 592 | 170 | TON | 4.7 | 28.91 | 23,099 | 75.00 | 12,750 | 35,849 |
| PRIMARY PUMPS 50 HP | 1 | EA | 100.0 | 28.91 | 2,891 | 8,200.00 | 8,200 | 11,091 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 500 | TON | 0.6 | 28.91 | 8,673 | 92.00 | 46,000 | 54,673 |
| RELOCATE COOLING TOWER AND PUMPS FROM BLDG 592 | 170 | TON | 1.2 | 28.91 | 5,898 | 35.00 | 5,950 | 11,848 |
| | | | | SUBTOTAL | 93,966 | | 393,580 | 487,546 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. B-3** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6B3 **DATE:** 3/2/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED | 59 | EA | 1.5 | 22.00 | 1,947 | 10.00 | 590 | 2,537 |
| REMOVE PACKAGE UNIT 4 TON | 1 | EA | 8.9 | 28.91 | 257 | 25.00 | 25 | 282 |
| REMOVE SPLIT SYSTEM 3-4 TON EQUIPMENT | 2 | EA | 10.0 | 28.91 | 578 | 50.00 | 100 | 678 |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 3" | 100 | LF | 0.6 | 28.91 | 1,735 | 15.70 | 1,570 | 3,305 |
| 2" | 100 | LF | 0.4 | 28.91 | 1,156 | 13.35 | 1,335 | 2,491 |
| 1-1/2" | 240 | LF | 0.4 | 28.91 | 2,498 | 12.85 | 3,084 | 5,582 |
| 1-1/4" | 320 | LF | 0.4 | 28.91 | 3,238 | 11.90 | 3,808 | 7,046 |
| 1" | 100 | LF | 0.3 | 28.91 | 925 | 10.65 | 1,065 | 1,990 |
| | | | | SUBTOTAL | 12,334 | | 11,577 | 23,911 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. B-3 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6B3

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 5 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND NEW CHW PUMPS COST PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 21.2 | 28.91 | 613 | 2,417.00 | 2,417 | 3,030 |
| 2" | 1 | LOC | 19.2 | 28.91 | 555 | 1,639.00 | 1,639 | 2,194 |
| 1-1/2" | 3 | LOC | 16.0 | 28.91 | 1,388 | 1,400.00 | 4,200 | 5,588 |
| 1-1/4" | 4 | LOC | 16.0 | 28.91 | 1,850 | 1,400.00 | 5,600 | 7,450 |
| 1" | 2 | LOC | 14.0 | 28.91 | 809 | 1,300.00 | 2,600 | 3,409 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 200 | EA | 0.5 | 28.91 | 2,891 | 7.05 | 1,410 | 4,301 |
| 1-1/2" | 500 | EA | 0.4 | 28.91 | 5,782 | 5.05 | 2,525 | 8,307 |
| 1" | 1,000 | EA | 0.3 | 28.91 | 8,673 | 4.38 | 4,380 | 13,053 |
| 3/4" | 2,000 | EA | 0.3 | 28.91 | 17,346 | 2.75 | 5,500 | 22,846 |
| | | | | SUBTOTAL | 39,907 | | 30,271 | 70,178 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6B3
**DATE:** 3/2/96

**ECO NO. B-3** Retrofit Existing Individual Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** I NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, | 56 | EA | 4.8 | 28.91 | 7,690 | 1,375.00 | 77,000 | 84,690 |
| CONTROL VALVE AND ELECTRIC CIRCUIT | | | | | | | | |
| AHU 2-PIPE W/ COIL, PIPING AND CONTROL VALVE | | | | | | | | |
| 4,5 TON | 1 | EA | 14.5 | 28.91 | 419 | 3,400.00 | 3,400 | 3,819 |
| 3 TON | 1 | EA | 12.0 | 28.91 | 347 | 3,000.00 | 3,000 | 3,347 |
| SUB TOTAL FROM SHEET 1 | | | | | 258,743 | | 239,930 | 498,673 |
| SUB TOTAL FROM SHEET 2 | | | | | 18,916 | | 57,774 | 76,690 |
| SUB TOTAL FROM SHEET 3 | | | | | 93,966 | | 393,580 | 487,546 |
| SUB TOTAL FROM SHEET 4 | | | | | 12,334 | | 11,577 | 23,911 |
| SUB TOTAL FROM SHEET 5 | | | | | 39,907 | | 30,271 | 70,178 |
| | | | | SUBTOTAL | 432,323 | | 816,532 | 1,248,855 |
| | | | | O & P @ 20% | 86,465 | | 163,306 | 249,771 |
| | | | | SUBTOTAL | 518,787 | | 979,839 | 1,498,626 |
| | | | | DESIGN @ 6% | | | | 89,918 |
| | | | | SUBTOTAL | | | | 1,588,543 |
| | | | | SIOH @ 5.5% | | | | 87,370 |
| | | | | TOTAL | | | | $1,675,913 |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. B-4 Retrofit Existing Individual Chillers

PROJECT NO: 03-0185.6B4

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A PHASE ONE 250923
Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER UP TO 100 TON | 100 | TON | 1.5 | 28.91 | 4,452 | 25.00 | 2,500 | 6,952 |
| RMV CHILLER UP TO 50 TON | 614 | TON | 1.6 | 28.91 | 28,579 | 25.00 | 15,350 | 43,929 |
| RMV WTR COOLED PACKAGE UNIT AND FLUID COOLER | 6 | EA | 8.9 | 28.91 | 1,544 | 50.00 | 300 | 1,844 |
| RMV DIRECT EXPANSION CONDENSER & AHU | 2 | EA | 5.0 | 28.91 | 289 | 50.00 | 100 | 389 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 6,000 | LF | 1.0 | 28.91 | 180,398 | 29.50 | 177,000 | 357,398 |
| 4" | 160 | LF | 0.8 | 28.91 | 3,469 | 19.55 | 3,128 | 6,597 |
| 3" | 400 | LF | 0.6 | 28.91 | 6,938 | 15.70 | 6,280 | 13,218 |
| 2-1/2" | 1,340 | LF | 0.5 | 28.91 | 18,595 | 13.33 | 17,862 | 36,457 |
| 2" | 640 | LF | 0.4 | 28.91 | 7,401 | 13.55 | 8,672 | 16,073 |
| 1-1/2" | 680 | LF | 0.4 | 28.91 | 7,077 | 12.85 | 8,738 | 15,815 |
| | | | | SUBTOTAL | 258,743 | | 239,930 | 498,673 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6B4

**DATE:** 3/2/96

**ECO NO. B-4** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 6" | 8 | EA | 2.1 | 28.91 | 481 | 590.00 | 4,720 | 5,201 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 500.0 | 20.00 | 10,000 | 9,000.00 | 9,000 | 19,000 |
| | | | | | | | | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 3 | LOC | 10.7 | 28.91 | 924 | 717.00 | 2,151 | 3,075 |
| 2-1/2" | 7 | LOC | 9.6 | 28.91 | 1,943 | 639.00 | 4,473 | 6,416 |
| 2" | 5 | LOC | 9.6 | 28.91 | 1,388 | 639.00 | 3,195 | 4,583 |
| 1-1/2" | 5 | LOC | 8.0 | 28.91 | 1,156 | 600.00 | 3,000 | 4,156 |
| ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE, | | | | | | | | |
| PIPING ASSEMBLY & ELECTRICAL | | | | | | | | |
| VERT FLOOR MNT AHU 2-PIPE 5 TON CAPACITY | 6 | EA | 10.0 | 28.91 | 1,735 | 3,900.00 | 23,400 | 25,135 |
| AHU W/ CHW COIL 2-PIPE 2000 CFM | 2 | EA | 14.5 | 28.91 | 838 | 3,400.00 | 6,800 | 7,638 |
| | | | | SUBTOTAL | 18,916 | | 57,774 | 76,690 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6B4 | DATE: 3/2/96 |
| ECO NO. B-4 Retrofit Existing Individual Chillers | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| CONSTRUCT CENTRAL PLANT BASE BUILDING | 1,000 | BSF | | | | 75.00 | 75,000 | 75,000 |
| HISTORICLY COMPATABLE | | | | | | | | |
| COOLING TOWER ENCLOSURE | 1 | SUM | 1.0 | 9,000.00 | 9,000 | 12,000.00 | 12,000 | 21,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 1,000 | BSF | | | | 34.00 | 34,000 | 34,000 |
| CHILLER WITH PIPING & VESELS | 480 | TON | 4.5 | 28.91 | 62,446 | 896.00 | 430,080 | 492,526 |
| GAS ENGINE DRIVEN R 134a | | | | | | | | |
| RELOCATE CHILLER FROM BLDG 592 | 170 | TON | 4.7 | 28.91 | 23,099 | 75.00 | 12,750 | 35,849 |
| PRIMARY PUMPS 50 HP | 1 | EA | 100.0 | 28.91 | 2,891 | 8,200.00 | 8,200 | 11,091 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 500 | TON | 0.6 | 28.91 | 8,673 | 92.00 | 46,000 | 54,673 |
| RELOCATE COOLING TOWER AND PUMPS FROM BLDG 592 | 170 | TON | 1.2 | 28.91 | 5,898 | 35.00 | 5,950 | 11,848 |
| | | | | SUBTOTAL | 112,006 | | 623,980 | 735,986 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6B4 | | DATE: 3/2/96 |
| ECO NO. B-4 Retrofit Existing Individual Chillers | BY : KOTHMANN, K | | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED | 59 | EA | 1.5 | 22.00 | 1,947 | 10.00 | 590 | 2,537 |
| REMOVE PACKAGE UNIT 4 TON | 1 | EA | 8.9 | 28.91 | 257 | 25.00 | 25 | 282 |
| REMOVE SPLIT SYSTEM 3-4 TON EQUIPMENT | 2 | EA | 10.0 | 28.91 | 578 | 50.00 | 100 | 678 |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 3" | 100 | LF | 0.6 | 28.91 | 1,735 | 15.70 | 1,570 | 3,305 |
| 2" | 100 | LF | 0.4 | 28.91 | 1,156 | 13.35 | 1,335 | 2,491 |
| 1-1/2" | 240 | LF | 0.4 | 28.91 | 2,498 | 12.85 | 3,084 | 5,582 |
| 1-1/4" | 320 | LF | 0.4 | 28.91 | 3,238 | 11.90 | 3,808 | 7,046 |
| 1" | 100 | LF | 0.3 | 28.91 | 925 | 10.65 | 1,065 | 1,990 |
| | | | | SUBTOTAL | 12,334 | | 11,577 | 23,911 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. B-4 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6B4

DATE: 3/2/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION SHEET 5 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND NEW CHW PUMPS COST PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 21.2 | 28.91 | 613 | 2,417.00 | 2,417 | 3,030 |
| 2" | 1 | LOC | 19.2 | 28.91 | 555 | 1,639.00 | 1,639 | 2,194 |
| 1-1/2" | 3 | LOC | 16.0 | 28.91 | 1,388 | 1,400.00 | 4,200 | 5,588 |
| 1-1/4" | 4 | LOC | 16.0 | 28.91 | 1,850 | 1,400.00 | 5,600 | 7,450 |
| 1" | 2 | LOC | 14.0 | 28.91 | 809 | 1,300.00 | 2,600 | 3,409 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 200 | EA | 0.5 | 28.91 | 2,891 | 7.05 | 1,410 | 4,301 |
| 1-1/2" | 500 | EA | 0.4 | 28.91 | 5,782 | 5.05 | 2,525 | 8,307 |
| 1" | 1,000 | EA | 0.3 | 28.91 | 8,673 | 4.38 | 4,380 | 13,053 |
| 3/4" | 2,000 | EA | 0.3 | 28.91 | 17,346 | 2.75 | 5,500 | 22,846 |
| | | | | SUBTOTAL | 39,907 | | 30,271 | 70,178 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. B-4** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6B4 **DATE:** 3/2/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** I NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN CENT R-134A
PHASE ONE 250923 Bldg SF Condition Space AREA 100

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, | 56 | EA | 4.8 | 28.91 | 7,690 | 1,375.00 | 77,000 | 84,690 |
| CONTROL VALVE AND ELECTRIC CIRCUIT | | | | | | | | |
| AHU 2-PIPE W/ COIL, PIPING AND CONTROL VALVE | | | | | | | | |
| 4,5 TON | 1 | EA | 14.5 | 28.91 | 419 | 3,400.00 | 3,400 | 3,819 |
| 3 TON | 1 | EA | 12.0 | 28.91 | 347 | 3,000.00 | 3,000 | 3,347 |
| SUB TOTAL FROM SHEET 1 | | | | | 258,743 | | 239,930 | 498,673 |
| SUB TOTAL FROM SHEET 2 | | | | | 18,916 | | 57,774 | 76,690 |
| SUB TOTAL FROM SHEET 3 | | | | | 112,006 | | 623,980 | 735,986 |
| SUB TOTAL FROM SHEET 4 | | | | | 12,334 | | 11,577 | 23,911 |
| SUB TOTAL FROM SHEET 5 | | | | | 39,907 | | 30,271 | 70,178 |
| SUBTOTAL | | | | | 450,363 | | 1,046,932 | 1,497,295 |
| O & P @ 20% | | | | | 90,073 | | 209,386 | 299,459 |
| SUBTOTAL | | | | | 540,435 | | 1,256,319 | 1,796,754 |
| DESIGN @ 6% | | | | | | | | 107,805 |
| SUBTOTAL | | | | | | | | 1,904,559 |
| SIOH @ 5.5% | | | | | | | | 104,751 |
| TOTAL | | | | | | | | $2,009,310 |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF MAINTENANCE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-0185.6MA | **DATE:** 3/2/96

**ECO NO. B** Retrofit Existing Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment
AREA 100

**ANNUAL COSTS**

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON EXISTING | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER CHILLER PER YEAR | | | | | | | | |
| | | | | | | | | |
| EXISTING WATER COOLEDCHILLERS | | EA | 200.0 | 30.00 | | 6,150.00 | | |
| EXISTING AIR COOLED CHILLERS | -699. | TON | 0.7 | 30.00 | -14,679 | 29.00 | -20,271 | -34,950 |
| EXISTING WINDOW UNITS | -59. | EA | 3.0 | 30.00 | -5,310 | 20.00 | -1,180 | -6,490 |
| EXISTING DX SYSTEM | -21.5 | TON | 1.0 | 30.00 | -645 | 5.00 | -108 | -753 |
| | | | | | | | | |
| | | | | | | | | |
| **NEW EQUIPMENT** | | | | | | | | |
| NEW WATER COOLED CHILLERS | 2. | EA | 190.0 | 30.00 | 11,400 | 6,150.00 | 4,020 | 15,420 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -9,234 | | -17,539 | -26,773 |

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Life Cycle Cost Analysis
Energy Conservation Investment Program (ECIP)

Study: FSH-100.LC
LCCID FY96

Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-B1
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $1,472,706 |
| B. SIOH | $85,859 |
| C. Design Cost | $88,362 |
| D. Total Cost (1A+1B+1C) | $1,646,927 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $1,646,927 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 4,350 | Mbtus | $27,318 | 15.08 | $411,955 |
| Elec. Deman | | | | | $37,558 | 14.88 | $558,863 |
| Natural Gas | $4.4 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 4,350 | Mbtus | $64,876 | | $970,819 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURR | $26,773 | Annual | 14.88 | $398,382 |
| ANNUAL TOTAL | $26,773 | | | $398,382 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $26,773 | | | $398,382 |

| | |
|---|---|
| 4. First Year Dollar Savings | $91,649 |
| 5. Simple Payback Period (Years) | 17.97 |
| 6. Total Net Discounted Savings | $1,369,201 |
| 7. Savings to Investment Ratio<br>If < 1, Project does not qualify | .83 |
| 8. Adjusted Internal Rate of Return | 2.05% |

Life Cycle Cost Analysis — Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-B2
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $1,493,308 |
| B. SIOH | $87,060 |
| C. Design Cost | $89,598 |
| D. Total Cost (1A+1B+1C) | $1,669,966 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $1,669,966 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 4,495 | Mbtus | $28,229 | 15.08 | $425,687 |
| Elec. Deman | | | | | $37,077 | 14.88 | $551,706 |
| Natural Gas | $4.4 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 4,495 | Mbtus | $65,306 | | $977,393 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURR | $26,773 | Annual | 14.88 | $398,382 |
| ANNUAL TOTAL | $26,773 | | | $398,382 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $26,773 | | | $398,382 |

| | |
|---|---|
| 4. First Year Dollar Savings | $92,079 |
| 5. Simple Payback Period (Years) | 18.14 |
| 6. Total Net Discounted Savings | $1,375,775 |
| 7. Savings to Investment Ratio<br>If < 1, Project does not qualify | .82 |
| 8. Adjusted Internal Rate of Return | 2.01% |

Life Cycle Cost Analysis Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
cal Year: 1996 Discrete Portion: ECO-B3
lysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $1,498,626 |
| B. SIOH | $87,370 |
| C. Design Cost | $89,918 |
| D. Total Cost (1A+1B+1C) | $1,675,914 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $1,675,914 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 4,244 | Mbtus | $26,652 | 15.08 | $401,917 |
| Elec. Deman | | | | | $35,298 | 14.88 | $525,234 |
| Natural Gas | $4.4 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| OTAL | | | 4,244 | Mbtus | $61,950 | | $927,151 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURR | $26,773 | Annual | 14.88 | $398,382 |
| ANNUAL TOTAL | $26,773 | | | $398,382 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $26,773 | | | $398,382 |

| | |
|---|---|
| 4. First Year Dollar Savings | $88,723 |
| 5. Simple Payback Period (Years) | 18.89 |
| 6. Total Net Discounted Savings | $1,325,534 |
| 7. Savings to Investment Ratio<br>If < 1, Project does not qualify | .79 |
| 8. Adjusted Internal Rate of Return | 1.8% |

Life Cycle Cost Analysis — Study: FSH-100.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-B4
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $1,796,754 |
| B. SIOH | $104,751 |
| C. Design Cost | $107,805 |
| D. Total Cost (1A+1B+1C) | $2,009,310 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $2,009,310 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 5,595 | Mbtus | $35,137 | 15.08 | $529,860 |
| Elec. Deman | | | | | $50,662 | 14.88 | $753,851 |
| Natural Gas | $4.4 | /Mbtus | -4,022 | Mbtus | -$17,657 | 18.58 | -$328,059 |
| TOTAL | | | 1,573 | Mbtus | $68,142 | | $955,651 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURR | $26,773 | Annual | 14.88 | $398,382 |
| ANNUAL TOTAL | $26,773 | | | $398,382 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $26,773 | | | $398,382 |

| | |
|---|---|
| 4. First Year Dollar Savings | $94,915 |
| 5. Simple Payback Period (Years) | 21.17 |
| 6. Total Net Discounted Savings | $1,354,034 |
| 7. Savings to Investment Ratio | .67 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | .99% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | D |
| DATE: | 3/1/96 |
| ECO TITLE: | Install Energy Management System (EMS) For HVAC System |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 500 (serving buildings 590, 591, 592) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 1957 | MMBTU/yr |
| Electrical Demand Savings | -401 | $/yr |
| Gas Energy Savings | 39 | MMBTU/yr |
| Total Energy Savings | 1996 | MMBTU/yr |
| Total Cost Savings | 12,024 | $/yr |
| Total Investment | 278,393 | $ |
| Simple Payback | 23.2 | yrs |
| SIR | 0.65 | |

B. ECO Description:

Install Energy Management System (EMS) at Building 592. The EMS will accomplish the following tasks for the equipment listed in Table-1 for all of the above mentioned buildings.

1. All AHU's serving buildings in the table below will be furnished with all necessary controls to facilitate an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode, which will save thermal cooling energy. (several damaged OA dampers require repairs).

2. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature.

3. All multi-zone units and all single zone units with reheat or without coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures after the reheat coil will be monitored. The cooling coil leaving air temperature will be reset to satisfy at least one zone thermostat without reheat.

4. All multi-zone units will have air side temperature reset. AHU heating supply air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full heat (at least one zone damper will be fully open).

5. Buildings 590, 591 and 592 chillers will have water temperature reset. The leaving CHW temperature will be reset to control varying load.

6. Building 592's chiller will have condenser water temperature reset. The CW leaving temperature will be maintained as low as OA conditions permit in the summer season.

Table-1

| Building # | Equipment To Be Controlled |
|---|---|
| 590 | Chiller, CHW pump, 3 AHUs, Boiler and HW pump |
| 591 | Chiller, CHW pump, 3 AHUs, Boiler and HW pump. |
| 592 | Chiller, CHW pump, cooling tower, CND pump, 5 AHUs, Boiler and HW pump. |

C. Discussion:

1. Generally, the ambient condition in the San Antonio area is warm and humid. Annual free cooling hours will be limited. A large number of AHUs are equipped with necessary dampers to support an economizer cycle. This indicates that the original HVAC system was designed to have an economizer cycle or a smoke purge system. All OA and RA dampers will be repaired and retrofitted with necessary controls to support an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode. When the enthalpy of the OA will drops below that of RA, the OA damper will open, and the RA damper will close. This action will reduce the cooling energy required. The benefit of this system will occur in both the heating and cooling season. In the heating season when the ambient temperature falls below the temperature needed to maintain the supply air at design conditions, the OA damper will remain in the preset minimum open position to permit necessary ventilation.

2. Currently the facility occupancy is 24 hours per day, 365 days per year. These barracks type housing facilities remain occupied during the weekends and on holidays. Due to the consistent occupancy, the optimum start / stop option has no opportunity and was not evaluated.

3. Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's. (Boilers and chillers have a seasonal operation, hot and cold air mixing never occurs, return air mixes with cold air in the summer and with hot air in winter.) In both cases cooling and heating energy is wasted. Currently the hot air plenum is acting as a return air plenum. Our observations indicate that all zones are mixing cold supply and return air to maintain the room or zone temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur. The same control sequence will be applied to the hot deck temperature control.

   In multi-zone units cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air

temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. (A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.)

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Field observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. Heating supply air temperature will be lowered until at least one zone damper remains fully open position to satisfy the room or an area heating demand. Many partially open heating dampers indicate a higher than necessary heating deck temperature. Lowering the temperature will save heating energy.

5. Chillers at all buildings will be furnished with chilled water temperature reset controls. Upon a decrease in ambient load, the leaving CHW temperature will increase. An increase in leaving CHW temperature decreases the KW/ton which will reduce the electrical energy required. The entering condenser water temperature will be reduced in certain weather conditions to further enhance the chiller efficiency.

6. Chillers at Building 592 will be furnished with condenser water temperature reset controls. As the differential pressure between the evaporator and condenser decreases, the energy required to operate the chiller compressor decreases. Therefore, a reduction in condenser water temperature will save energy. However, the cooling tower fan energy will increase to produce a lower condenser water temperature. Multi-step thermostats, monitoring devices, and controls will be installed to operate the condenser water reset option. The EMS system will monitor and activate the reset program when atmospheric conditions permit, and when the energy savings from the chiller compressor exceed the additional cooling tower fan energy required to produce a lower condenser water temperature.

   The EMS system will be controlled by a personal computer (PC) located in the central maintenance building. All other buildings control panels will be connected to the central EMS system PC in the Building via telephone lines.

D. Savings Calculations:

1. *Energy Consumption And Savings*

   The monthly peak demand and energy consumption of the existing and proposed EMS system were calculated using the Trace 600 computer program [1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

   Once the computer simulations of the existing and new EMS system were completed, the total annual demand cost and energy consumption were compared with that of the

existing and new systems to determine the annual savings for this ECO. These savings calculations are shown on pages C-69 and C-70. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings with this retrofit.

E. Cost Estimates:

The total installation costs for the new EMS system are estimated on pages C-71 Through C-73. These costs were generated from the I/O point list shown on page C-68. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-74. The data from the summary sheet were presented in the ECO summary on page C-64.

REFERENCES

1. Refer to Appendix A for utility cost analysis data used in the savings calculations.

2. Refer to Appendix G for building field data and existing HVAC equipment data.

| AREA: 500 | HARDWARE | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | | | | |
| ECO D: INSTALL EMS FOR HVAC EQUIPMENT<br>OCCUPANCY TIME:<br>GRAPHIC DISPLAY ●<br>POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS |
| | | | | | | | | | | | | | | | | | | | | | |
| W/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 1 | | | | | | | | | | | | | | | | 1 |
| CHW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | |
| CW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | |
| TWR. FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 1 | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 1 | | | |
| CW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 1 | | | |
| CW RETURN HEADER | | | | | | | | | | | | | | | | | | 1 | | | |
| TWR. BYPASS VALVE | | | | | | | | 1 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| A/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 2 | | | | | | | | | | | | | | | | |
| CHW PUMP | 2 | | | | | | | | | | | | | | 2 | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 2 | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 2 | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| HW BOILERS ● | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 3 | | | | | | | 3 | | | | | | | | | |
| HW PUMP | 3 | | | | | | | | | | | | | | 3 | | | | | | |
| HW SUPPLY HEADER | | | | | | | | | | | | | | | | | | | | | |
| HW RETURN HEADER | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| AHU (MZ) ● | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 11 | | | | | | | | | | | | | | 11 | | | | | | |
| COLD DECK TEMP. | | | | | | 11 | | | | | | | | | | | | 11 | | | |
| HOT DECK TEMP. | | | | | | 11 | | | | | | | | | | | | 11 | | | |
| RETURN AIR | | | | | | | 11 | | | | | | | | | | | 11 | | | |
| ZONE DAMPERS | | | | | | | 47 | | | | | | | | | | | | | | |
| OUTSIDE AIR | | | | | | | 11 | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 47 | | | |
| FILTER | | | | | | | | | | 11 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| OUTSIDE AIR ● | | | | | | | | | | | | | | | | | | 1 | 1 | | |
| | | | | | | | | | | | | | | | | | | | | | |

TOTAL AO POINTS = 25

TOTAL DO POINTS = 92

TOTAL AI POINTS = 33

TOTAL DI POINTS = 92

GRAND TOTAL POINTS = 242

| INPUT | | | | | | | | | | | SOFTWARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ANALOG | | | | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | |
| LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE | DIFFERENITAL PRESSURE | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | [illegible] |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 1 | | | | | | | | | | | | | | | X | | | | | | | | | | | | X | | X | | | X | X | X | | |
| | | | | | | | | | | | X | | | | | | | | X | | | | | | | | | | | | | | | | | X | | | | |
| | | | | | | | | | | | X | | | | | | | | X | | | | | | | | | | | | | | | | | X | | | | |
| | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | X | | | | X | | | | |
| | 1 | | | | | | | | 1 | | | | | X | X | | | | | | | | | | | | | | | | X | | | | | | | | | |
| | 1 | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | X | | | | | | | | | |
| | 1 | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | X | | | | | | | | |
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| | 2 | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | X | | | | | | | | | |
| | 2 | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | X | | | | | | | | | |
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| | | | | | | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | 11 | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | |
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| | 47 | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | |
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| RUN TIME | KW | KWH | CFM | [illegible] | | REMARKS |
|---|---|---|---|---|---|---|
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| X | | | | | | actuators are existing. |
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500 AREA

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 590 Chiller | | | | | 73.2 | 73.1 | 78.5 | 78.2 | 69.6 | 55.0 | | | 144,252 | |
| Bldg. 590 CHW Pump | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| Bldg. 590 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 591 Chiller | | | | | 73.2 | 73.1 | 78.5 | 78.2 | 69.6 | 55.0 | | | 144,252 | |
| Bldg. 591 CHW Pump | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| Bldg. 591 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 592 Chiller | | | | | 99.6 | 101.1 | 104.1 | 105.4 | 102.5 | 72.0 | | | 202,124 | |
| Bldg. 592 Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 60,050 | |
| Bldg. 592 CHW Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 592 CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 592 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 590 Airside Fans | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 98,112 | |
| Bldg. 591 Airside Fans | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 98,112 | |
| Bldg. 592 Airside Fans | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 98,112 | |
| Bldg. 592 Airside Fans | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 391,572 | |
| Bldg. 590 Boiler | | | | | | | | | | | | | | 97 |
| Bldg. 590 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 9,557 | |
| Bldg. 590 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 591 Boiler | | | | | | | | | | | | | | 96 |
| Bldg. 591 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 5,676 | |
| Bldg. 591 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 322 | |
| Bldg. 592 Boiler | | | | | | | | | | | | | | 219 |
| Bldg. 592 HW Pump | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 8,603 | |
| Bldg. 592 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 291 | |
| Totals | 86.7 | 86.7 | 86.7 | 86.7 | 372.0 | 373.3 | 387.1 | 387.8 | 367.7 | 308.0 | 86.7 | 86.7 | 1,406,422 | 412 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 650 | 650 | 650 | 650 | 2,790 | 3,733 | 3,871 | 3,878 | 3,677 | 2,310 | 650 | 650 | | |

| | | |
|---|---|---|
| Total Demand | 24,161 $/yr | |
| Total Energy | 4,800 MMBTU/yr | (electric) |
| Total Energy | 412 MMBTU/yr | (gas) |

| ITEM | ECO D - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 590 Chiller | | | | | 77.1 | 80.7 | 83.8 | 83.5 | 77.5 | 42.1 | | | 107,153 | |
| Bldg. 590 CHW Pump | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| Bldg. 590 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 591 Chiller | | | | | 77.1 | 80.7 | 83.8 | 83.5 | 77.5 | 42.1 | | | 107,153 | |
| Bldg. 591 CHW Pump | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| Bldg. 591 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 592 Chiller | | | | | 99.6 | 102.7 | 104.1 | 105.4 | 102.5 | 71.7 | | | 173 | |
| Bldg. 592 Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,798 | |
| Bldg. 592 CHW Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 592 CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 592 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 590 Airside Fans | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 57,232 | |
| Bldg. 591 Airside Fans | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 57,232 | |
| Bldg. 592 Airside Fans | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 40,612 | |
| Bldg. 592 Airside Fans | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 228,417 | |
| Bldg. 590 Boiler | | | | | | | | | | | | | | 89 |
| Bldg. 590 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 9,557 | |
| Bldg. 590 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 591 Boiler | | | | | | | | | | | | | | 88 |
| Bldg. 591 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 5,401 | |
| Bldg. 591 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 307 | |
| Bldg. 592 Boiler | | | | | | | | | | | | | | 197 |
| Bldg. 592 HW Pump | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 8,443 | |
| Bldg. 592 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 285 | |
| Totals | 86.7 | 86.7 | 86.7 | 86.7 | 379.8 | 390.1 | 397.7 | 398.4 | 383.5 | 281.9 | 86.7 | 86.7 | 833,150 | 373 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 650 | 650 | 650 | 650 | 2,849 | 3,901 | 3,977 | 3,984 | 3,835 | 2,114 | 650 | 650 | | |

| | | | |
|---|---|---|---|
| Total Demand | 24,561 | $/yr | |
| Demand Savings | -401 | $/yr | |
| Energy Savings | 1,957 | MMBTU/yr | (electric) |
| Energy Savings | 39 | MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| **LOCATION:** FORT SAM HOUSTON , SAN ANTONIO,TX | **PROJECT NO:** 03-0185.06D | **DATE:** 9/18/96 |
| **ECO NO. D AREA 500** | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J. |

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | HRS/ UNIT | Rate | Total | Unit Price | Total | |
| EMCS COSTS BASED ON DDC ALL ELECTRIC | | | | | | | | |
| DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE | | | | | | | | |
| DIGITAL OUTPUT DEVICE : | | | | | | | | |
| START-STOP MOTOR | 19 | EA | 10.2 | 28.91 | 5,603 | 175.74 | 3,339 | 8,942 |
| ENABLE/DISABLE APPARATUS RELAY | 6 | EA | 4.5 | 28.91 | 781 | 49.00 | 294 | 1,075 |
| ANALOG OUTPUT: | | | | | | | | |
| CONTROL VALVE (COIL/AHU ACTUATOR ONLY) | 23 | EA | 11.9 | 28.91 | 7,926 | 571.00 | 13,133 | 21,059 |
| DAMPER ACTUATOR & MOTOR | 58 | EA | 11.9 | 28.91 | 19,987 | 340.00 | 19,720 | 39,707 |
| DIGITAL INPUT: | | | | | | | | |
| DIFFERENTIAL PREASURE SWITCH | 11 | EA | 10.1 | 28.91 | 3,212 | 227.30 | 2,500 | 5,712 |
| AUXILIARY CONTACT | 3 | EA | 4.5 | 28.91 | 390 | 49.00 | 147 | 537 |
| CURRENT SENSING RELAY | 19 | EA | 4.5 | 28.91 | 2,472 | 49.00 | 931 | 3,403 |
| SHEET 1 | | | | | | | | |
| | | | | SUBTOTAL | 40,371 | | 40,064 | 80,435 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO,TX
**ECO NO. D** AREA 500

**PROJECT NO:** 03-0185.06D
**BY :** KOTHMANN, K

**DATE:** 9/18/96
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | UNIT MEAS. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| ANALOG INPUT: | | | | | | | | |
| TEMP. SENSER & THERMO WELL | 30 | EA | 17.0 | 28.91 | 14,744 | 426.42 | 12,793 | 27,537 |
| TEMP. SENSER AIR DUCT | 11 | EA | 12.0 | 28.91 | 3,816 | 450.00 | 4,950 | 8,766 |
| TEMP. SENSER OUTSIDE AIR | 1 | EA | 12.0 | 28.91 | 347 | 550.00 | 550 | 897 |
| TEMP. SENSER ZONE | 47 | EA | 12.0 | 28.91 | 16,305 | 556.00 | 26,132 | 42,437 |
| RELATIVE HUMIDITY % | 1 | EA | 13.0 | 28.91 | 376 | 615.00 | 615 | 991 |
| AMPERES | 1 | EA | 7.0 | 28.91 | 202 | 219.00 | 219 | 421 |
| GAUGE PRESURE BOILER | | EA | 8.0 | 28.91 | | 197.00 | | |
| FLOW STATUS / RATE | 1 | EA | 17.0 | 28.91 | 491 | 410.00 | 410 | 901 |
| EQUIPMENT FAILURE ALARM | 8 | EA | 2.6 | 28.91 | 601 | 108.00 | 864 | 1,465 |
| FILTER ALARM | 11 | EA | 4.5 | 28.91 | 1,431 | 227.00 | 2,497 | 3,928 |
| HIGH & LOW LIMIT (HYDRONIC) | 14 | PR | 2.0 | 28.91 | 809 | 170.00 | 2,380 | 3,189 |
| SHEET 2 | | | | | | | | |
| | | | | SUBTOTAL | 39,124 | | 51,410 | 90,534 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO,TX

**ECO NO. D** **AREA 500**

**PROJECT NO:** 03-0185.06D

**DATE:** 9/18/96

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| OPERATORS' WORKSTATION UNIT | 1 | SUM | | | | 13,184.00 | 13,184 | 13,184 |
| INCLUDING MODEM & REMOTE PANEL | | | | | | | | |
| SUBMITTALS, TRAINING & START-UP | 1 | JOB | | | | 8,300.00 | 8,300 | 8,300 |
| SOFTWARE | 1 | LS | | | | 15,000.00 | 15,000 | 15,000 |
| SUB TOTAL FROM SHEET 1 | | | | | 40,371 | | 40,064 | 80,435 |
| SUB TOTAL FROM SHEET 2 | | | | | 39,124 | | 51,410 | 90,534 |
| SUBTOTAL | | | | | 79,494 | | 127,958 | 207,452 |
| O & P @ 20% | | | | | 15,899 | | 25,592 | 41,490 |
| SUBTOTAL | | | | | 95,393 | | 153,550 | 248,943 |
| DESIGN @ 6% | | | | | | | | 14,937 |
| SUBTOTAL | | | | | | | | 263,879 |
| SIOH @ 5.5% | | | | | | | | 14,513 |
| TOTAL | | | | | | | | $278,393 |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-D
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment
   A. Construction Cost $248,943
   B. SIOH $14,513
   C. Design Cost $14,937
   D. Total Cost (1A+1B+1C) $278,393
   E. Salvage Value of Existing Equip. $0
   F. Public Utility Company Rebate $0
   G. Total Investment (1D-1E-1F) $278,393

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 1,957 | Mbtus | $12,290 | 15.08 | $185,333 |
| Elec. Deman | | | | | -$401 | 14.88 | -$5,967 |
| Natural Gas | $3.5 | /Mbtus | 39 | Mbtus | $135 | 18.58 | $2,507 |
| TOTAL | | | 1,996 | Mbtus | $12,024 | | $181,873 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

4. First Year Dollar Savings $12,024
5. Simple Payback Period (Years) 23.15
6. Total Net Discounted Savings $181,873
7. Savings to Investment Ratio .65
   If < 1, Project does not qualify
8. Adjusted Internal Rate of Return .83%

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | E |
| DATE: | 3/1/96 |
| ECO TITLE: | Retrofit Existing Individual Chillers With Central Chillers |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 500, Buildings 590, 591, 592 |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 705 | MMBTU/yr |
| Electrical Demand Savings | 3743 | $/yr |
| Gas Energy Savings | 0 | MMBTU/yr |
| Total Energy Savings | 705 | MMBTU/yr |
| Total Cost Savings | 17,250 | $/yr |
| Total Investment | 516,826 | $ |
| Simple Payback | 30.0 | yrs |
| SIR | 0.50 | |

A. ECO Description:

All of these buildings are equipped with dedicated liquid chillers for cooling. Buildings 590 and 591 have air cooled reciprocating chillers. Both of these reciprocating chillers will be removed. The water cooled centrifugal chiller, cooling tower, and condenser water pump serving building 592 will be removed and turned over to the owner for relocation. A new R-123, 300 ton water cooled centrifugal chiller with 0.57 KW/ton will be installed in it's place. One new 25 HP primary CHW pump selected at 600 GPM and 110 ft head and a new 20 HP CW pump selected at 900 GPM and 60 ft. hd be installed. Also, a new crossflow, induced draft cooling tower with a 15 HP motor will be installed to support the new chiller. The cooling tower will be installed on the existing pad and basin but the existing CW piping with 8" steel pipe will be replaced.

Primary CHW will be pumped through a direct buried 6" primary CHW supply and return piping loop to Building 590 and 591. Primary CHW piping will split into two 3" branches under the parking lot of Building 591 (approximately 1000 ft. of 5" and 1200 ft. of 3" piping will be required). These branches will be connected with the existing CHW pumps of the Building 590 and 591. The existing CHW pumps for Buildings 590, 591 and 592 will be reutilized as secondary CHW pumps. All AHU, CHW coil three way control valves will be converted to two way valves to minimize pumping energy. The existing controls and electrical service should be reutilized wherever possible, and new controls and electrical services should be installed at Building 592 to serve the new CHW pump. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new chiller, cooling tower, associated wiring and controls.

B. Discussion:

Buildings 590 and 591 are served by two 66.5 ton air cooled reciprocating liquid chillers. Both were installed in 1986. Generally the reciprocating chiller efficiency remains around 1.2 KW/ton.

as these are 10 year old chillers, they could have an efficiency of 1.35 to as high as 1.5 KW/ton. Therefore a single 300 ton, R-123 centrifugal chiller will be installed at Building 592. A 170 ton R-123, centrifugal chiller at Building 592 was installed in 1995. This chiller is in very good condition and will be removed along with it's cooling tower and condenser water pump and relocated if needed. The primary factor for replacing these chillers with a central chiller is due to the added maintenance cost associated with maintaining both air cooled and water cooled chillers and with the part load efficiency of the air cooled machines. Therefore it is recommended that a central chiller plant, consisting of a new 300 ton water cooled chiller be installed to serve these buildings. Computer simulations of the buildings in this area determined that the current installed capacity of 320 tons is more than adequate to handle the load for the buildings; therefore, we recommend installing a 300 ton machine. All AHU, CHW coil three way control valves will be converted to two way valves to minimize the pumping energy and for better distribution of CHW flow through the AHU coils.

C. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed chillers and pumps were calculated using the Trace 600 computer program[1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

There were several types of chillers modeled including centrifugal, screw, variable speed driven centrifugal, and gas engine driven. Water cooled R-123 centrifugal machines are more efficient in their full load KW/ton ratings over the screw or gas engine driven machines, while the screw machines were approximately 10% more efficient in the part load range between 25% -50%. Full load performance data from York International was used in the computer simulations of the new chiller energy usage, while part load data was available from equipment supplied with Trace 600. An equipment list of the specific chillers and pumps modeled for the new chiller are shown on pages C-79 through C-81. Once the computer simulations of the existing and new chiller plants were completed, the total annual demand cost and energy consumption of each chiller was compared with that of the existing chiller to determine the annual savings for this ECO[3]. These savings calculations are shown on pages C-82 and C-83. These demand and energy savings values were used in the life cycle cost analysis. The results of these savings calculations were as follows:

| Alternative | Chiller Type | Demand Savings $/yr | Electrical Savings MMBTU/yr | Gas Savings MMBTU/yr |
|---|---|---|---|---|
| **E1** | Electric Centrifugal | 3832 | 477 | 0 |
| **E2** | Electric Centrifugal & VFD | 3743 | 705 | 0 |
| **E3** | Electric Screw | 3122 | 485 | 0 |

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water and air cooled chillers in this area down to one water cooled chiller. The total maintenance cost savings from this ECO is estimated to be $9,080 per year as calculated on page C-93. This figure was used in the life cycle cost analysis.

D. Cost Estimates:

The total installation costs for the new central chiller plant were estimated on pages C-84 through C-92. These costs were used in the life cycle cost analysis and are summarized below:

| Alternative | Chiller Type | Estimated Cost |
|---|---|---|
| **E1** | Electric Centrifugal | $509,725 |
| **E2** | Electric Centrifugal & VFD | $524,826 |
| **E3** | Electric Screw | $527,841 |

E. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A one time savings of $8,000 was included for the salvage value of the chiller serving building 592. This cost was estimated from information supplied by Entech Sales ad Service located in Dallas, Texas. The summary sheets for the life cycle cost analysis of each alternative are shown on pages C-94 through C-96. The results of the alternative life cycle cost analysis were as follows:

| Alternative | Chiller Type | Payback Years | SIR |
|---|---|---|---|
| **E1** | Electric Centrifugal | 31.5 | 0.47 |
| **E2** | Electric Centrifugal & VFD | 30.0 | 0.50 |
| **E3** | Electric Screw | 34.1 | 0.44 |

Since the electric centrifugal chiller and VFD has the highest SIR, it is recommended as the most economical choice to replace the existing machine. The data from the life cycle cost analysis for this alternative were included in the summary on page C-75.

# REFERENCES

1. Refer to Appendix H for the system thermal load profile.

2. Refer to Appendix G for building field data and existing HVAC equipment consumption data.

3. Refer to Appendix A for utility analysis and avoided cost calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-E1, FORT SAM HOUSTON, AREA 500

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YT<br>water cooled, centrifugal,<br>300 tons, R-123 | Area 500 | New | 171 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>600 gpm, 110 ft<br>25 HP | Area 500 | New | 18.60 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>900 gpm, 60 ft<br>20 HP | Area 500 | New | 14.90 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>15 HP fan | Area 100 | New | 11.20 KW |
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PROPOSED HVAC EQUIPMENT LIST FOR: ECO-E2, FORT SAM HOUSTON, AREA 500

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YT with VFD<br>water cooled, centrifugal,<br>300 tons, R-123 | Area 500 | New | 171 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>600 gpm, 110 ft<br>25 HP | Area 500 | New | 18.60 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>900 gpm, 60 ft<br>20 HP | Area 500 | New | 14.90 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>15 HP fan | Area 100 | New | 11.20 KW |
| | | | | | |
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PROPOSED HVAC EQUIPMENT LIST FOR: ECO-E3, FORT SAM HOUSTON, AREA 500

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YS<br>water cooled screw<br>300 tons, R-123 | Area 100 | New | 186 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>600 gpm, 110 ft<br>25 HP | Area 500 | New | 18.60 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>900 gpm, 60 ft<br>20 HP | Area 500 | New | 14.90 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>15 HP fan | Area 100 | New | 11.20 KW |
| | | | | | |
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500 AREA

| ITEM | ECO E - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 590 Chiller | | | | | 73.2 | 73.1 | 78.5 | 78.2 | 69.6 | 55.0 | | | 144,252 | |
| Bldg. 590 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 591 Chiller | | | | | 73.2 | 73.1 | 78.5 | 78.2 | 69.6 | 55.0 | | | 144,252 | |
| Bldg. 591 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 592 Chiller | | | | | 99.6 | 101.1 | 104.1 | 105.4 | 102.5 | 72.0 | | | 202,124 | |
| Bldg. 592 Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 60,050 | |
| Bldg. 592 CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 592 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Totals | | | | | 275.1 | 276.4 | 290.2 | 290.9 | 270.8 | 211.1 | | | 613,385 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | | | | | 2,063 | 2,764 | 2,902 | 2,909 | 2,708 | 1,583 | | | | |

| | | | |
|---|---|---|---|
| Total Demand | 14,930 | $/yr | |
| Total Energy | 2,093 | MMBTU/yr | (electric) |
| Total Energy | | MMBTU/yr | (gas) |

| ITEM | ECO-E1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (300 TON) | | | | | 162.2 | 160.9 | 168.4 | 171.7 | 159.8 | 101.3 | | | 276,223 | |
| Cooling Tower | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 45,078 | |
| CHW Pump | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 82,138 | |
| CND Pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,798 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 207.9 | 206.6 | 214.1 | 217.4 | 205.5 | 147.0 | | | 473,653 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | | | | | 1,559 | 2,066 | 2,141 | 2,174 | 2,055 | 1,103 | | | | |

| | | | |
|---|---|---|---|
| Total Demand | 11,098 | $/yr | |
| Demand Savings | 3,832 | $/yr | |
| Energy Savings | 477 | MMBTU/yr | (electric) |
| Energy Savings | | MMBTU/yr | (gas) |

| ITEM | ECO-E2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (300 TON) | | | | | 171.0 | 168.3 | 171.0 | 172.0 | 162.7 | 106.2 | | | 246,700 | |
| Cooling Tower | | | | | 8.2 | 8.4 | 10.1 | 11.2 | 9.1 | 2.7 | | | 7,754 | |
| CHW Pump | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 82,138 | |
| CND Pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,798 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 213.7 | 211.2 | 215.6 | 217.7 | 206.3 | 143.4 | | | 406,806 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | | | | | 1,603 | 2,112 | 2,156 | 2,177 | 2,063 | 1,076 | | | | |

| | | | |
|---|---|---|---|
| Total Demand | 11,186 | $/yr | |
| Demand Savings | 3,743 | $/yr | |
| Energy Savings | 705 | MMBTU/yr | (electric) |
| Energy Savings | | MMBTU/yr | (gas) |

| ITEM | ECO-E3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (300 TON) | | | | | 177.3 | 175.8 | 183.3 | 186.0 | 174.4 | 102.6 | | | 273,868 | |
| Cooling Tower | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 45,063 | |
| CHW Pump | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 82,138 | |
| CND Pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,798 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 223.0 | 221.5 | 229.0 | 231.7 | 220.1 | 148.3 | | | 471,283 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | | | | | 1,673 | 2,215 | 2,290 | 2,317 | 2,201 | 1,112 | | | | |

| | | | |
|---|---|---|---|
| Total Demand | 11,808 | $/yr | |
| Demand Savings | 3,122 | $/yr | |
| Energy Savings | 485 | MMBTU/yr | (electric) |
| Energy Savings | | MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6E1

**DATE:** 9/18/96

**ECO NO. E-1** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| SHEET 1 | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER UP TO 100 TON | 133 | TON | 1.5 | 28.91 | 5,921 | 25.00 | 3,325 | 9,246 |
| RMV CHILLER OVER 100 TON | 170 | TON | 1.3 | 28.91 | 6,389 | 25.00 | 4,250 | 10,639 |
| RMV COOLING TOWER | 1 | EA | 60.0 | 28.91 | 1,735 | 550.00 | 550 | 2,285 |
| RMV CONDENSER PUMP & LOOP | 1 | EA | 820.0 | 28.91 | 23,706 | 300.00 | 300 | 24,006 |
| DISCOUNT FOR SALVAGE | 1 | EA | | | | | | -8,000 |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 1,000 | LF | 1.0 | 28.91 | 30,066 | 29.50 | 29,500 | 59,566 |
| 8" | 160 | LF | 1.5 | 28.91 | 6,938 | 40.00 | 6,400 | 13,338 |
| 3" | 1,200 | LF | 0.6 | 28.91 | 20,815 | 15.70 | 18,840 | 39,655 |
| SECTIONALIZING VALVE AND BOX 6" | 2 | EA | 2.1 | 28.91 | 120 | 5,902.00 | 11,804 | 11,924 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 3" | 3 | LOC | 10.7 | 28.91 | 928 | 717.00 | 2,151 | 3,079 |
| | | | | SUBTOTAL | 96,620 | | 77,120 | 165,740 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
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512 MAIN STREET, SUITE 1500
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. E-1** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6E1 **DATE:** 9/18/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 200.0 | 20.00 | 4,000 | 3,000.00 | 3,000 | 7,000 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 300 | TON | 3.2 | 28.91 | 27,754 | 371.00 | 111,300 | 139,054 |
| PRIMARY PUMPS 20 HP | 1 | EA | 16.0 | 28.91 | 463 | 825.00 | 825 | 1,288 |
| PRIMARY PUMPS 25 HP | 1 | EA | 16.0 | 28.91 | 463 | 825.00 | 825 | 1,288 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 300 | TON | 0.6 | 28.91 | 5,204 | 92.00 | 27,600 | 32,804 |
| CONTROLS | 1 | JOB | 200.0 | 28.91 | 5,782 | 10,500.00 | 10,500 | 16,282 |
| ELECTRICAL | 1 | JOB | 80.0 | 28.91 | 2,313 | 2,400.00 | 2,400 | 4,713 |
| TEST BALANCE AND START-UP | 1 | JOB | 120.0 | 28.91 | 3,469 | 200.00 | 200 | 3,669 |
| | | | | SUBTOTAL | 49,447 | | 156,650 | 206,097 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. E-1 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6E1

DATE: 9/18/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 96,620 | | 77,120 | 173,740 |
| SUB TOTAL FROM SHEET 2 | | | | | 49,447 | | 156,650 | 206,097 |
| SUBTOTAL | | | | | 146,066 | | 233,770 | 379,836 |
| O & P @ 20% | | | | | 29,213 | | 46,754 | 75,967 |
| SUBTOTAL | | | | | 175,279 | | 280,524 | 455,803 |
| DESIGN @ 6% | | | | | | | | 27,348 |
| SUBTOTAL | | | | | | | | 483,151 |
| SIOH @ 5.5% | | | | | | | | 26,573 |
| TOTAL | | | | | | | | $509,725 |


**HUITT-ZOLLARS, INC.**
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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6E1
**DATE:** 9/18/96

**ECO NO. E-2** Retrofit Existing Individual Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER UP TO 100 TON | 133 | TON | 1.5 | 28.91 | 5,921 | 25.00 | 3,325 | 9,246 |
| RMV CHILLER OVER 100 TON | 170 | TON | 1.3 | 28.91 | 6,389 | 25.00 | 4,250 | 10,639 |
| RMV COOLING TOWER | 1 | EA | 60.0 | 28.91 | 1,735 | 550.00 | 550 | 2,285 |
| RMV CONDENSER PUMP & LOOP | 1 | EA | 820.0 | 28.91 | 23,706 | 300.00 | 300 | 24,006 |
| DISCOUNT FOR SALVAGE | 1 | EA | | | | | | -8,000 |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 1,000 | LF | 1.0 | 28.91 | 30,066 | 29.50 | 29,500 | 59,566 |
| 8" | 160 | LF | 1.5 | 28.91 | 6,938 | 40.00 | 6,400 | 13,338 |
| 3" | 1,200 | LF | 0.6 | 28.91 | 20,815 | 15.70 | 18,840 | 39,655 |
| SECTIONALIZING VALVE AND BOX 6" | 2 | EA | 2.1 | 28.91 | 120 | 5,902.00 | 11,804 | 11,924 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 3" | 3 | LOC | 10.7 | 28.91 | 928 | 717.00 | 2,151 | 3,079 |
| | | | | SUBTOTAL | 96,620 | | 77,120 | 165,740 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. E-2** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6E2 **DATE:** 9/18/96

**BY:** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 200.0 | 20.00 | 4,000 | 3,000.00 | 3,000 | 7,000 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 300 | TON | 3.2 | 28.91 | 27,754 | 371.00 | 111,300 | 139,054 |
| ADD FOR VFD | 65 | HP | 0.8 | 28.91 | 1,503 | 150.00 | 9,750 | 11,253 |
| PRIMARY PUMPS 20 HP | 1 | EA | 16.0 | 28.91 | 463 | 825.00 | 825 | 1,288 |
| PRIMARY PUMPS 25 HP | 1 | EA | 16.0 | 28.91 | 463 | 825.00 | 825 | 1,288 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 300 | TON | 0.6 | 28.91 | 5,204 | 92.00 | 27,600 | 32,804 |
| CONTROLS | 1 | JOB | 200.0 | 28.91 | 5,782 | 10,500.00 | 10,500 | 16,282 |
| ELECTRICAL | 1 | JOB | 80.0 | 28.91 | 2,313 | 2,400.00 | 2,400 | 4,713 |
| TEST BALANCE AND START-UP | 1 | JOB | 120.0 | 28.91 | 3,469 | 200.00 | 200 | 3,669 |
| | | | | SUBTOTAL | 50,950 | | 166,400 | 217,350 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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**ENGINEERS / ARCHITECTS**
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FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6E2 | DATE: 9/18/96 |
| ECO NO. E-2 Retrofit Existing Individual Chillers | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 96,620 | | 77,120 | 173,740 |
| SUB TOTAL FROM SHEET 2 | | | | | 50,950 | | 166,400 | 217,350 |
| SUBTOTAL | | | | | 147,569 | | 243,520 | 391,089 |
| O & P @ 20% | | | | | 29,514 | | 48,704 | 78,218 |
| SUBTOTAL | | | | | 177,083 | | 292,224 | 469,307 |
| DESIGN @ 6% | | | | | | | | 28,158 |
| SUBTOTAL | | | | | | | | 497,466 |
| SIOH @ 5.5% | | | | | | | | 27,361 |
| TOTAL | | | | | | | | $524,826 |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6E3 | DATE: 9/18/96 |
| ECO NO. E-3 Retrofit Existing Individual Chillers | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION SHEET 1 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER UP TO 100 TON | 133 | TON | 1.5 | 28.91 | 5,921 | 25.00 | 3,325 | 9,246 |
| RMV CHILLER OVER 100 TON | 170 | TON | 1.3 | 28.91 | 6,389 | 25.00 | 4,250 | 10,639 |
| RMV COOLING TOWER | 1 | EA | 60.0 | 28.91 | 1,735 | 550.00 | 550 | 2,285 |
| RMV CONDENSER PUMP & LOOP | 1 | EA | 820.0 | 28.91 | 23,706 | 300.00 | 300 | 24,006 |
| DISCOUNT FOR SALVAGE | 1 | EA | | | | | | -8,000 |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 1,000 | LF | 1.0 | 28.91 | 30,066 | 29.50 | 29,500 | 59,566 |
| 8" | 160 | LF | 1.5 | 28.91 | 6,938 | 40.00 | 6,400 | 13,338 |
| 3" | 1,200 | LF | 0.6 | 28.91 | 20,815 | 15.70 | 18,840 | 39,655 |
| SECTIONALIZING VALVE AND BOX 6" | 2 | EA | 2.1 | 28.91 | 120 | 5,902.00 | 11,804 | 11,924 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 3" | 3 | LOC | 10.7 | 28.91 | 928 | 717.00 | 2,151 | 3,079 |
| | | | | SUBTOTAL | 96,620 | | 77,120 | 165,740 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. E-3** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6E3

**DATE:** 9/18/96

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 200.0 | 20.00 | 4,000 | 3,000.00 | 3,000 | 7,000 |
| CHILLER (YORK YS) WITH PIPING & VESELS | 300 | TON | 3.2 | 28.91 | 27,754 | 416.00 | 124,800 | 152,554 |
| PRIMARY PUMPS 20 HP | 1 | EA | 16.0 | 28.91 | 463 | 825.00 | 825 | 1,288 |
| PRIMARY PUMPS 25 HP | 1 | EA | 16.0 | 28.91 | 463 | 825.00 | 825 | 1,288 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 300 | TON | 0.6 | 28.91 | 5,204 | 92.00 | 27,600 | 32,804 |
| CONTROLS | 1 | JOB | 200.0 | 28.91 | 5,782 | 10,500.00 | 10,500 | 16,282 |
| ELECTRICAL | 1 | JOB | 80.0 | 28.91 | 2,313 | 2,400.00 | 2,400 | 4,713 |
| TEST BALANCE AND START-UP | 1 | JOB | 120.0 | 28.91 | 3,469 | 200.00 | 200 | 3,669 |
| | | | | SUBTOTAL | 49,447 | | 170,150 | 219,597 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. E-3 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6E3

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL SCREW R-123
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 96,620 | | 77,120 | 173,740 |
| SUB TOTAL FROM SHEET 2 | | | | | 49,447 | | 170,150 | 219,597 |
| SUBTOTAL | | | | | 146,066 | | 247,270 | 393,336 |
| O & P @ 20% | | | | | 29,213 | | 49,454 | 78,667 |
| SUBTOTAL | | | | | 175,279 | | 296,724 | 472,003 |
| DESIGN @ 6% | | | | | | | | 28,320 |
| SUBTOTAL | | | | | | | | 500,323 |
| SIOH @ 5.5% | | | | | | | | 27,518 |
| TOTAL | | | | | | | | $527,841 |


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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-0185.6MA

DATE: 9/18/96

ECO NO. E Retrofit Existing Chillers

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 500

ANNUAL COSTS

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON EXISTING | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER CHILLER PER YEAR | | | | | | | | |
| EXISTING WATER COOLEDCHILLERS | -1. | EA | 200.0 | 30.00 | -6,000 | 6,150.00 | -6,150 | -12,150 |
| EXISTING AIR COOLED CHILLERS | -133. | TON | 0.7 | 30.00 | -2,793 | 29.00 | -3,857 | -6,650 |
| EXISTING WINDOW UNITS | | EA | 3.0 | 30.00 | | 20.00 | | |
| EXISTING DX SYSTEM | | TON | 1.0 | 30.00 | | 5.00 | | |
| **NEW EQUIPMENT** | | | | | | | | |
| NEW WATER COOLED CHILLERS | 1. | EA | 190.0 | 30.00 | 5,700 | 6,150.00 | 4,020 | 9,720 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -3,093 | | -5,987 | -9,080 |

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Life Cycle Cost Analysis
Energy Conservation Investment Program (ECIP)
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-E1
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

Study: FSH-2.LC
LCCID FY96

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $455,803 |
| B. SIOH | $26,573 |
| C. Design Cost | $27,348 |
| D. Total Cost (1A+1B+1C) | $509,724 |
| E. Salvage Value of Existing Equip. | 8000 |
| F. Public Utility Company Rebate | 0 |
| G. Total Investment (1D-1E-1F) | $501,724 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 477 | Mbtus | $2,996 | 15.08 | $45,173 |
| Elec. Deman | | | | | $3,832 | 14.88 | $57,020 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 477 | Mbtus | $6,828 | | $102,193 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECUR | $9,080 | Annual | 14.88 | $135,110 |
| ANNUAL TOTAL | $9,080 | | | $135,110 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $9,080 | | | $135,110 |

| | |
|---|---|
| 4. First Year Dollar Savings | $15,908 |
| 5. Simple Payback Period (Years) | 31.54 |
| 6. Total Net Discounted Savings | $237,304 |
| 7. Savings to Investment Ratio | .47 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | -.78% |

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-E2
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $469,307 |
| B. SIOH | $27,361 |
| C. Design Cost | $28,158 |
| D. Total Cost (1A+1B+1C) | $524,826 |
| E. Salvage Value of Existing Equip. | 8000 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $516,826 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 705 | Mbtus | $4,427 | 15.08 | $66,765 |
| Elec. Deman | | | | | $3,743 | 14.88 | $55,696 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 705 | Mbtus | $8,170 | | $122,461 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECUR | $9,080 | Annual | 14.88 | $135,110 |
| ANNUAL TOTAL | $9,080 | | | $135,110 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $9,080 | | | $135,110 |

| | |
|---|---|
| 4. First Year Dollar Savings | $17,250 |
| 5. Simple Payback Period (Years) | 29.96 |
| 6. Total Net Discounted Savings | $257,571 |
| 7. Savings to Investment Ratio | .5 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | -.52% |

Life Cycle Cost Analysis                                    Study: FSH-2.LC
Energy Conservation Investment Program (ECIP)                LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS                Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-E3
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $472,003 |
| B. SIOH | $27,518 |
| C. Design Cost | $28,320 |
| D. Total Cost (1A+1B+1C) | $527,841 |
| E. Salvage Value of Existing Equip. | 8000 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $519,841 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 485 | Mbtus | $3,046 | 15.08 | $45,931 |
| Elec. Deman | | | | | $3,122 | 14.88 | $46,455 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 485 | Mbtus | $6,168 | | $92,386 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECUR | $9,080 | Annual | 14.88 | $135,110 |
| ANNUAL TOTAL | $9,080 | | | $135,110 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $9,080 | | | $135,110 |

| | |
|---|---|
| 4. First Year Dollar Savings | $15,248 |
| 5. Simple Payback Period (Years) | 34.09 |
| 6. Total Net Discounted Savings | $227,496 |
| 7. Savings to Investment Ratio | .44 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | -1.17% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | F |
| DATE: | 3/1/96 |
| ECO TITLE: | Retrofit Existing Individual HW Boilers With Central HW Boilers |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 500 (serving buildings 590, 591, 592) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | -109 | MMBTU/yr |
| Electrical Demand Savings | -329 | $/yr |
| Gas Energy Savings | 79 | MMBTU/yr |
| Total Energy Savings | -30 | MMBTU/yr |
| Total Cost Savings | 7240 | $/yr |
| Total Investment | 164,799 | $ |
| Simple Payback | 22.8 | yrs |
| SIR | 0.66 | |

B. ECO Description:

Remove the existing boilers or heating equipment as shown in Table-1. In building 592, the removal of this boiler will leave enough space where one 2,000 MBH modular high efficiency HW boiler will be installed. A new stainless steel flue will be installed to remove the combustion gases from the boiler in the place of the existing flue. One 10 HP primary HW pump selected at 172 GPM and 120 ft. hd.. will be installed to serve the buildings listed in table 1. For the distribution loop, provide a direct buried 3" primary HW supply and return piping loop to Buildings 590 and 591. This primary HW loop will run parallel (if necessary) with new primary CHW lines and split into two 2" branches, under the parking lot of the Building 591. The one branch will be extended up to Building 591, and the second branch be will be extended up to Building 590. An estimated 1000 ft of 3" and 1200 ft. of 2" pipes will be required to complete this loop. All existing building HW pumps will be reutilized as secondary pumps and they will be connected to the new primary loop. All existing localized chemical treatment systems for each building except building 592 will be removed. Utilize existing chemical treatment in Building 592 to serve new boiler. Utilize existing electrical service, and provide new controls in Building 592. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new boilers and associated wiring and controls.

Table-1

| Bldg. # | Quantity | Description | Size Tons | Flow GPM | Estimated Pipe Size inches | Extimated Pipe Length Feet |
|---|---|---|---|---|---|---|
| 590 | 1 | HW boiler | 381.8 | 52 | 2 | 600 |
| 591 | 1 | HW boiler | 623.9 | 55 | 2 | 600 |
| 592 | 1 | HW boiler | 2037 | 280 | 3 | 60 |
| Total | 3 | HW Equipment | 3043 | 387 | N/A | N/A |

C. Discussion:

Buildings 590, 591 and 592 are served by three natural draft gas fired boilers. All boilers are located in three different locations, remote to each other. They generally appear to be in fair condition, but they show indications of rusting and leaks. However, the cost of maintaining these boilers is excessive and difficult for the maintenance staff. Moreover, these older natural draft boilers are very inefficient. Their efficiency is between the range of 62% to 70%. It is recommended that in central boiler plant, one 2000 MBH high efficiency gas fired high efficiency modular HW boilers be installed. These boilers are 86% efficient under full load conditions, and reach upwards to 98% efficiency under part load conditions. Moreover, these boilers have the capability to be staged to maintain these part load efficiencies by remote boiler control. Another advantage of the modular boiler is its compactness. The size of the boilers make it very economical in retrofit projects because of their small footprint. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. This will save heating energy and greatly reduce the maintenance cost of the installation. Computer simulations of the buildings in this area determined that the current installed capacity of 3040 MBH is more than required to adequately heat the buildings. Therefore it is recommended that one new 2000 MBH boiler be installed to more closely match the existing system.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed boilers and pumps were calculated using the Trace 600 computer program[1]. The buildings served by the existing boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

The 2000 MBH high efficiency modular boiler has better part load performance ratings than common firetube or watertube boilers. Moreover, the ease of retrofitting existing equipment with these smaller footprint boilers makes them very cost effective. Full and part load performance data from Aerco Incorporated was used in the computer simulations of the new boiler energy usage. An equipment list of the proposed boiler and pumps modeled for the new central plant is shown on page C-100.

Once the computer simulations of the existing and new boiler plants were completed, the total annual energy consumption of the new central plant was compared with that of the existing individual systems to determine the annual savings for this ECO[3]. These savings

calculations are shown on page C-101. These energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of boilers to one modular boiler. The total maintenance cost savings from this ECO is estimated to be $7,980 per year as calculated on page C-106. This figure was used in the life cycle cost analysis.

E. Cost Estimates:

The total installation costs for the new central chiller plant were estimated on pages C-102 through C-105. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-107. The data from the summary sheet were presented in the ECO summary on page C-97.

## REFERENCES


1. Refer to Appendix H for the system thermal load profile.
2. Refer to Appendix G for building field data and existing HVAC equipment. data.
3. Refer to Appendix A for utility cost analysis and avoided cost calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-F, FORT SAM HOUSTON, AREA 500

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Hot Water Boiler | 1 | Aerco #KC-2000 GWB<br>natural draft, watertube<br>1830 MBH output | Area 2200 | New | 2,000 MBH |
| Heating Water Pump | 1 | Bell & Gossett<br>172 gpm, 120 ft<br>10 HP | Area 2200 | New | 7.50 KW |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| ITEM | ECO-F EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 590 Boiler | | | | | | | | | | | | | | 97 |
| Bldg. 590 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 591 Boiler | | | | | | | | | | | | | | 96 |
| Bldg. 591 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 322 | |
| Bldg. 592 Boiler | | | | | | | | | | | | | | 219 |
| Bldg. 592 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 291 | |
| Totals | 0.3 | 0.3 | 0.3 | 0.3 | | | | | | | 0.3 | 0.3 | 1,156 | 412 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 2 | 2 | 2 | 2 | | | | | | | 2 | 2 | | |

| | | |
|---|---|---|
| Total Demand | 14 $/yr | |
| Total Energy | 4 MMBTU/yr | (electric) |
| Total Energy | 412 MMBTU/yr | (gas) |

| ITEM | ECO-F: INSTALL CENTRAL BOILER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| High % modular boiler | | | | | | | | | | | | | | 333 |
| HW pump | 7.5 | 7.5 | 7.5 | 7.5 | | | | | | | 7.5 | 7.5 | 32,580 | |
| HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 7.6 | 7.6 | 7.6 | 7.6 | | | | | | | 7.6 | 7.6 | 33,123 | 333 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 57 | 57 | 57 | 57 | | | | | | | 57 | 57 | | |

| | | |
|---|---|---|
| Total Demand | 342 $/yr | |
| Demand Savings | -329 $/yr | |
| Energy Savings | -109 MMBTU/yr | (electric) |
| Energy Savings | 79 MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6F

**DATE:** 9/18/96

**ECO NO. F Retrofit Existing Individual Boilers AREA 500**

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER HVAC Equipment
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| REMOVE BOILER 500 MBH AND UP | 1 | EA | 90.0 | 28.91 | 2,602 | 780.00 | 780 | 3,382 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 3" | 1,000 | LF | 0.6 | 28.91 | 17,346 | 15.70 | 15,700 | 33,046 |
| 2" | 1,200 | LF | 0.4 | 28.91 | 13,877 | 13.55 | 16,260 | 30,137 |
| | | | | SUBTOTAL | 33,825 | | 32,740 | 66,565 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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FORT WORTH, TEXAS 76102-3922
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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6F | | DATE: 9/18/96 |
| ECO NO. F Retrofit Existing Individual Boilers AREA 500 | BY : KOTHMANN, K | | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 3" | 2 | EA | 7.0 | 28.91 | 405 | 475.00 | 950 | 1,355 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 150.0 | 20.00 | 3,000 | 2,000.00 | 2,000 | 5,000 |
| SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING HW PUMPS PER LOCATION | | | | | | | | |
| 2" | 2 | LOC | 9.6 | 28.91 | 555 | 639.00 | 1,278 | 1,833 |
| 3" | 1 | LOC | 10.7 | 28.91 | 309 | 717.00 | 717 | 1,026 |
| | | | | SUBTOTAL | 4,269 | | 4,945 | 9,214 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FT SAM HOUSTON , SAN ANTONIO TEX

**PROJECT NO:** 03-185.6F **DATE:** 9/18/96

**ECO NO. F** Retrofit Existing Individual Boilers AREA 500

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install New Boiler AERCO # KC 2000 1830 MBH | 1 | EA | 100.00 | 28.91 | 2,891 | 18500.00 | 18,500 | 21,391 |
| Install New Pump 10 HP | 1 | EA | 15.00 | 28.91 | 434 | 2800.00 | 2,800 | 3,234 |
| pipe Assembly & valves Boiler | 1 | EA | 28.00 | 28.91 | 809 | 2400.00 | 2,400 | 3,209 |
| pipe Assembly & valves Pump | 1 | EA | 12.00 | 28.91 | 347 | 1350.00 | 1,350 | 1,697 |
| Boiler Breaching | 1 | JOB | 30.00 | 28.91 | 867 | 2000.00 | 2,000 | 2,867 |
| Controls | 1 | JOB | 90.00 | 28.91 | 2,602 | 3900.00 | 3,900 | 6,502 |
| Electrical | 1 | JOB | 80.00 | 28.91 | 2,313 | 3500.00 | 3,500 | 5,813 |
| Test , Balance & Start-up | 1 | LS | 80.00 | 28.91 | 2,313 | | | 2,313 |
| | | | | SUBTOTAL | 12,576 | | 34,450 | 47,026 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6F

**DATE:** 9/18/96

**ECO NO. F** Retrofit Existing Individual Boilers AREA 500

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
116351 Bldg SF Condition Space AREA 500

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 33,825 | | 32,740 | 66,565 |
| SUB TOTAL FROM SHEET 2 | | | | | 4,269 | | 4,945 | 9,214 |
| SUB TOTAL FROM SHEET 3 | | | | | 12,576 | | 34,450 | 47,026 |
| SUBTOTAL | | | | | 50,670 | | 72,135 | 122,805 |
| O & P @ 20% | | | | | 10,134 | | 14,427 | 24,561 |
| SUBTOTAL | | | | | 60,804 | | 86,562 | 147,366 |
| DESIGN @ 6% | | | | | | | | 8,842 |
| SUBTOTAL | | | | | | | | 156,208 |
| SIOH @ 5.5% | | | | | | | | 8,591 |
| TOTAL | | | | | | | | $164,799 |

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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.6MA | DATE: 9/18/96 |
| ECO NO. F Retrofit Existing BOILERS | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 500

ANNUAL COSTS

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER BOILER PER YEAR | | | | | | | | |
| EXISTING BOILER | -3. | EA | 100.0 | 30.00 | -9,000 | 1,800.00 | -5,400 | -14,400 |
| **NEW EQUIPMENT** | | | | | | | | |
| AERCO MODULAR HIGH EFFICIENCY HW BOILER | 1. | EA | 80.0 | 30.00 | 2,400 | 1,500.00 | 4,020 | 6,420 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -6,600 | | -1,380 | -7,980 |

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Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-F
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $147,366 |
| B. SIOH | $8,591 |
| C. Design Cost | $8,842 |
| D. Total Cost (1A+1B+1C) | $164,799 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | 0 |
| G. Total Investment (1D-1E-1F) | $164,799 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | -109 | Mbtus | -$685 | 15.08 | -$10,323 |
| Elec. Deman | | | | | -$329 | 14.88 | -$4,896 |
| Natural Gas | $3.5 | /Mbtus | 79 | Mbtus | $273 | 18.58 | $5,079 |
| TOTAL | | | -30 | Mbtus | -$740 | | -$10,139 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECUR | $7,980 | Annual | 14.88 | $118,742 |
| ANNUAL TOTAL | $7,980 | | | $118,742 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $7,980 | | | $118,742 |

| | |
|---|---|
| 4. First Year Dollar Savings | $7,240 |
| 5. Simple Payback Period (Years) | 22.76 |
| 6. Total Net Discounted Savings | $108,603 |
| 7. Savings to Investment Ratio | .66 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | .87% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | G |
| DATE: | 3/1/96 |
| ECO TITLE: | Install Energy Management System (EMS) For HVAC System |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas, |
| LOCATION: | Area 1000 (serving buildings 1000, 1001, 1029, 1088) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 832 | MMBTU/yr |
| Electrical Demand Savings | 149 | $/yr |
| Gas Energy Savings | -94 | MMBTU/yr |
| Total Energy Savings | 838 | MMBTU/yr |
| Total Cost Savings | 5049 | $/yr |
| Total Investment | 266,445 | $ |
| Simple Payback | 52.8 | yrs |
| SIR | 0.28 | |

B. ECO Description:

Install an Energy Management System (EMS) at the central maintenance facility. The EMS will accomplish the following tasks for the equipment listed in Table-1 in all of the above mentioned buildings:

1. All AHU's serving buildings 1001 and 1029 in the table below will be furnished with all necessary controls to facilitate an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode., which will save thermal cooling energy. (several damaged OA dampers will require repairs).

2. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps for Buildings 1001 and 1029. At Building 1029 only three AHUs located on second floor through fourth floor are included in this option. (Building 1000 is not included in this option.) Chillers, boilers, and their associated auxiliaries and the first floor AHU will be operated as usual. All other units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, equipment can be started as late as possible and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature.

3. All multi-zone units and all single zone units with or without reheat coils in their branches will have a cooling side discharge air temperature reset at Building 1001. Three AHUs located on the first through third floors will have this option. All other

AHUs at Buildings 1000 and 1029 are not included. All branch thermostats and zone supply air temperatures after the reheat coil will be monitored. The cooling coil leaving air temperature will be reset to satisfy at least one zone thermostat without reheat.

4. All multi-zone units will have air side temperature reset. AHU heating supply air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full heat (at least one zone damper will be fully open). At Building 1001, three AHUs located on the first through third floors will have this option. All other AHUs at Buildings 1000 and 1029 are not included.

5. All HW boilers will have water temperature reset. The HW boiler leaving temperature will be controlled with varying OA conditions in the winter season. Buildings 1000 and 1029 are included in this option. Building 1001 is not included.

6. Chiller serving Buildings 1000 and 1029 will have chilled water temperature reset. The leaving CHW temperature will be reset to maintain varying load conditions.

7. Building 1000, and 1029 chillers will have condenser water temperature reset. The CW leaving temperature will be maintained as low as OA conditions permit in summer season.

Table-1

| Building # | Equipment To Be Controlled |
|---|---|
| 1000 | 2 Chillers, 2 CND & CHW pumps , 2 cooling towers, 3 HW Boilers, 3 HW pumps |
| 1001 | 4 AHUs. |
| 1029 | Chiller, 1 CHW & CND pump, cooling tower, 8 AHUs, HW Boiler, HW pump |

C. Discussion:

1 Generally, the ambient condition in the San Antonio area is warm and humid. Annual free cooling hours will be limited. A large number of AHUs are equipped with necessary dampers to support an economizer cycle. This indicating that the original HVAC system was designed to have an economizer cycle or a smoke purge system. All OA and RA dampers will be repaired and retrofitted with necessary controls to support an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode. When the enthalpy of the OA drops below that of RA, then the OA damper will open, and the RA damper will close. This action will reduce the cooling energy required. The benefit of this system will occur in both the heating and cooling season. In the heating season when the ambient temperature falls below the temperature needed to maintain the supply air at design conditions, the OA damper will remain in the preset minimum open position to permit necessary ventilation. Building 1000 is a hospital, it is served by over 400 FCUs, single zone and multi-zone units. This building will not be retrofitted with this option because most to all of the units that would benefit from having economizer control currently operate with it. Therefore, this control

option was not modeled in the simulation of the existing system serving building 1000.

2. Generally Buildings 1001 and 1029 are occupied from 7:30 a.m. to 5:00 p.m. daily with the exceptions of the library and emergency transport system (EMT) located on the basement and first floor of the Building 1001, which remains occupied at all times. All other areas of this building follow the above schedule. With the exceptions of the library and EMT, the facility remains unoccupied during the weekends and holidays. Moreover, because building 1000 is a hospital and operates continuously, it will not be retrofitted with this option. The primary CHW equipment serving Building 1001 also serves Building 1002, a military barrack, which is occupied 24 hours per day, 365 days per year. Therefore Building 1001 primary cooling system is also not retrofitted with this option.

   Regardless of occupancy hours, all AHU's in buildings 1001 and 1029 are operated 24 hours per day, 365 days per year to maintain space temperature. However, the chillers operate only during the cooling season as do the boilers in the heating season. Depending on occupancy schedules, ambient conditions and building thermal characteristics, most AHU's and their associated chillers, boilers , CHW and HW pumps will be turned off daily in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHU's will remain off during weekends and holidays.

   Several temperature sensors will be installed in the spaces served by these AHU's. These sensors will monitor the space temperature during unoccupied hours. During the cooling season when the space temperature exceeds 85 F, the AHUs and their associated cooling auxiliaries serving that space will energize to cool the space below 85 F. When the space temperature reaches 84 F, they will cycle off. Similarly, the winter time unoccupied period space temperature will be maintained at 65 F.

3. Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's (The boiler and chiller have a seasonal operation which means hot and cold air mixing never occurs. It is actually return air mixing with cold air in the summer and with hot air in winter.). In both cases, cooling and heating energy is wasted. Currently, the hot air plenum is acting as a return air plenum. Field observations indicate that all zones are mixing cold supply and return air to maintain the room or zone temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur. The same control sequence will be applied to the hot deck temperature control.

   In multi-zone units cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. (A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.) The fourth floor AHU at

Building 1001 and all AHUs at Building 1029 are single zone units without reheat coils, They are not included in this option. Building 1000 will not be retrofitted with this option because of the strict temperature and humidity requirements in the spaces being served by the air handling units. The potential savings that would result from those units would be minimal compared to the cost of retrofitting them.

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Field observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. The heating supply air temperature will be lowered until at least one zone damper will remain in the fully open position to satisfy the room or an area heating demand. Many partially open heating dampers indicate a higher than necessary heating deck temperature. Therefore, lowering the temperature will save heating energy. The fourth floor AHU at Building 1001 and all AHUs at Building 1029 are single zone units without reheat coils, and they are not included in this option. Building 1000 is a hospital will also not be retrofitted with this option for the same reasons as described in Option 3.

5. Currently most HW boilers maintain a preset boiler leaving water temperature. A HW reset supply temperature controller will be installed to linearly reset the HW supply temperature with the change in the outside air temperature. As the outside air temperature rises from 32 °F to 65°F, the HW supply temperature will be reset from the design temperature to the boiler minimum required temperature. Maintaining a higher leaving HW temperature than necessary wastes heating energy, therefore, lowering this supply temperature will save heating energy. Building 1001 has steam boilers, and is not included in this option.

6. Chillers at all buildings except the one serving building 1001 will be furnished with chilled water temperature reset controls. Upon a decrease in ambient temperature, the leaving CHW temperature will increase. An increase in leaving CHW temperature decreases the KW/ton which will reduce the electrical energy required. The entering condenser water temperature will be reduced in certain weather conditions to further enhance the chiller efficiency.

7. Chillers at all buildings will be furnished with condenser water temperature reset controls. As the differential pressure between the evaporator and condenser decreases, the energy required to operate the chiller compressor decreases. Therefore, a reduction in condenser water temperature will save energy. However, the cooling tower fan energy will increase to produce a lower condenser water temperature. Multi-step thermostats monitoring devices and controls will be installed to operate the condenser water reset option. The EMS system will monitor and activate the reset program when atmospheric conditions permit, and when the energy savings from the chiller's compressor exceed the additional cooling tower fan energy consumption.

The EMS system will be controlled by a personal computer (PC) located in the central maintenance building. All other buildings control panels will be connected to the central EMS system PC in the building via telephone lines.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed EMS system were calculated using the Trace 600 computer program[1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations of the existing and new EMS system were completed, the total annual demand cost and energy consumption were compared with that of the existing and new systems to determine the annual savings for this ECO[3]. These savings calculations are shown on pages C-115 through C-118. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings associated with this retrofit.

E. Cost Estimates:

The total installation costs for the new EMS system are estimated on pages C-119 through C-121. This cost was estimated using an I/O point summary shown on pages C-113 through C-114. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-122. The data from the summary sheet were presented in the ECO summary on page C-108.

REFERENCES

1. Refer to appendix H for computer modeling assumptions, data, and output.

2. Refer to Appendix G for building and equipment HVAC system data.

3. Refer to Appendix A for utility cost analysis and avoided cost calculations.

| AREA: 1000 | HARDWARE | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | | | |
| ECO G: INSTALL EMS FOR HVAC EQUIPMENT | | | | | | | | | | | | | | | | | | | | | | | | | |
| OCCUPANCY TIME: VARIES | | | | | | | | | | | | | | | | | | | | | | | | | |
| GRAPHIC DISPLAY ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE | DIFFERENITAL PRESSURE | POSITION |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| W/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 2 | | | | | | | | | | | | | | | | 2 | | | | |
| CHW PUMP | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| CW PUMP | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| TWR. FAN | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| CW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| CW RETURN HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
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| HW BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
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| HW PUMP | 3 | | | | | | | | | | | | | | 3 | | | | | | | | | | |
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| HW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
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| ECO G: INSTALL EMS FOR HVAC EQUIPMENT | | | | | | | | | | | | | | | | | | | | | | | | | |
| OCCUPANCY TIME: VARIES | | | | | | | | | | | | | | | | | | | | | | | | | |
| GRAPHIC DISPLAY ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE | DIFFERENITAL PRESSURE | POSITION |
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| SUPPLY FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
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| RETURN AIR | | | | | | | | | | | | | | | | | | | | | | | | | |
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| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
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| AHU (FACE AND BYPASS-SZ) ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 7 | | | | | | | | | | | | | | 7 | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 7 | | | | | | | | | | | | 7 | | | | | | | |
| HOT DECK TEMP. | | | | | | 7 | | | | | | | | | | | | 7 | | | | | | | |
| BYPASS DAMPER | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 7 | | | | | | | |
| OUTSIDE AIR | | | | | | | 7 | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 7 | | | | | | | |
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| AHU (MZ) ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 2 | | | | | | | | | | | | 2 | | | | | | | |
| HOT DECK TEMP. | | | | | | 2 | | | | | | | | | | | | 2 | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| OUTSIDE AIR | | | | | | | 2 | | | | | | | | | | | | | | | | | | |
| ZONE DAMPERS | | | | | | | 8 | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 8 | | | | | | | |
| FILTER | | | | | | | | | | 2 | | | | | | | | | | | | | | | |
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| AHU (MZ) ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
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| RETURN AIR | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
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| ZONE DAMPERS | | | | | | | 4 | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 4 | | | | | | | |
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TOTAL AO POINTS = 37

TOTAL DO POINTS = 53

TOTAL AI POINTS = 45

TOTAL DI POINTS = 96

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| | X | | | | | | and bldg. 1001 4th floor ahu |
| | | | | | | | |
| | | | | | | | all valves, dampers, thermostats, and |
| | | | | | | | actuators are existing. |
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| | | | | | | | |
| | | | | | | | bldg. 1001 2nd - 3rd floor ahus |
| | X | | | | | | |
| | | | | | | | all valves, dampers, thermostats, and |
| | | | | | | | actuators are existing. |
| | | | | | | | |
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| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | bldg. 1001 1st floor ahu |
| | X | | | | | | |
| | | | | | | | all valves, dampers, thermostats, and |
| | | | | | | | actuators are existing. |
| | | | | | | | |
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| | | | | | | | |

## 1000 AREA

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1000 Chiller (CHLR-1) | 90.5 | 57.9 | 203.2 | 208.4 | 185.3 | 212.4 | 223.3 | 233.8 | 206.8 | 213.1 | 212.1 | 99.5 | 994,677 | |
| Bldg. 1000 Cooling Tower Fans | 11.4 | 2.8 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 13.7 | 106,916 | |
| Bldg. 1000 CHW Pump | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 326,748 | |
| Bldg. 1000 CND Pump | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 261,048 | |
| Bldg. 1000 CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 8,760 | |
| Bldg. 1000 Chiller (CHLR-2) | | | 120.6 | 163.1 | 203.7 | 233.5 | 245.4 | 256.9 | 227.3 | 146.9 | 127.9 | | 897,779 | |
| Bldg. 1000 Cooling Tower Fans | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | 93,878 | |
| Bldg. 1000 CHW Pump | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | 188,738 | |
| Bldg. 1000 CND Pump | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | 150,788 | |
| Bldg. 1000 CHW Controls | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | 5,060 | |
| Bldg. 1001 Window Units | 6.4 | 6.4 | 6.4 | 6.7 | 7.2 | 7.5 | 7.7 | 7.7 | 7.2 | 6.7 | 6.4 | 6.4 | 10,623 | |
| Bldg. 1001 Window Unit Fans | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.8 | 1.0 | 1.0 | 0.7 | 0.6 | 0.0 | 0.0 | 1,412 | |
| Bldg. 1001 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 876 | |
| Bldg. 1001 Chiller | | | | | 60.1 | 61.2 | 63.8 | 63.9 | 57.6 | 40.6 | | | 121,332 | |
| Bldg. 1001 Cooling Tower Fans | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 45,605 | |
| Bldg. 1001 CHW Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 1001 CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 1001 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1029 Chiller | | | | | 62.2 | 62.7 | 65.8 | 68.1 | 64.7 | 49.6 | | | 115,128 | |
| Bldg. 1029 Cooling Tower Fans | | | | | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | | | 30,036 | |
| Bldg. 1029 CHW Pump | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 82,138 | |
| Bldg. 1029 CND Pump | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 82,138 | |
| Bldg. 1029 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1000 Fan | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 176,076 | |
| Bldg. 1000 Fan | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 113,880 | |
| Bldg. 1000 Fan | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 179,580 | |
| Bldg. 1000 Fan | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 261,048 | |
| Bldg. 1000 Fan | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Bldg. 1000 Fan | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 19,272 | |
| Bldg. 1001 Fan | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Bldg. 1001 Fan | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 147,168 | |
| Bldg. 1029 Fan | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 150,672 | |
| Bldg. 1000 Boiler | | | | | | | | | | | | | | 10,809 |
| Bldg. 1000 HW Pump | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 162,936 | |
| Blodg. 1000 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1,095 | |
| Bldg. 1000 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 1000 HW Pump | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | |
| Bldg. 1000 HW Controls | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | |

1000 AREA

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1000 LPS Boiler | | | | | | | | | | | | | | 2,591 |
| Bldg. 1000 LPS Boiler Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 1001 LPS Boiler | | | | | | | | | | | | | | 123 |
| Bldg. 1001 LPS Boiler Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 288 | |
| Bldg. 1029 Boiler | | | | | | | | | | | | | | 130 |
| Bldg. 1029 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 3,520 | |
| Bldg. 1029 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 200 | |
| | | | | | | | | | | | | | | |
| Totals | 326.6 | 285.4 | 653.8 | 701.8 | 920.6 | 979.5 | 1008.4 | 1032.8 | 965.7 | 858.9 | 670.0 | 337.9 | 4,929,176 | 13,652 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 2,450 | 2,141 | 4,904 | 5,264 | 6,905 | 9,795 | 10,084 | 10,328 | 9,657 | 6,442 | 5,025 | 2,534 | | |

| | | |
|---|---|---|
| Total Demand | 75,527 $/yr | |
| Total Energy | 16,823 MMBTU/yr | (electric) |
| Total Energy | 13,652 MMBTU/yr | (gas) |

| ITEM | ECO G - INSTALL EMS AIRSIDE SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1000 Chiller (CHLR-1) | 79.7 | 51.2 | 202.4 | 207.6 | 181.6 | 209.9 | 221.3 | 232.3 | 204.0 | 213.1 | 212.0 | 89.7 | 957,825 | |
| Bldg. 1000 Cooling Tower Fans | 18.6 | 17.7 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 146,283 | |
| Bldg. 1000 CHW Pump | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 326,748 | |
| Bldg. 1000 CND Pump | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 261,048 | |
| Bldg. 1000 CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 8,760 | |
| Bldg. 1000 Chiller (CHLR-2) | | | 115.2 | 158.0 | 199.6 | 230.7 | 243.3 | 255.4 | 224.3 | 141.6 | 122.4 | | 874,932 | |
| Bldg. 1000 Cooling Tower Fans | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | 94,116 | |
| Bldg. 1000 CHW Pump | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | 188,738 | |
| Bldg. 1000 CW Pump | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | 150,788 | |
| Bldg. 1000 CHW Controls | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | 5,060 | |
| Bldg. 1001 Window Units | 6.4 | 6.4 | 6.4 | 6.7 | 7.2 | 7.5 | 7.7 | 7.7 | 7.2 | 6.7 | 6.4 | 6.4 | 9,968 | |
| Bldg. 1001 Window Unit Fans | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.8 | 1.0 | 1.0 | 0.8 | 0.6 | 0.0 | 0.0 | 1,338 | |
| Bldg. 1001 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 876 | |
| Bldg. 1001 Chiller | | | | | 63.7 | 63.1 | 64.6 | 65.5 | 63.3 | 40.5 | | | 118,358 | |
| Bldg. 1001 Cooling Tower Fans | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 44,891 | |
| Bldg. 1001 CHW Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 45,136 | |
| Bldg. 1001 CW Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 45,136 | |
| Bldg. 1001 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,030 | |
| Bldg. 1029 Chiller | | | | | 65.9 | 67.0 | 69.1 | 70.1 | 67.9 | 47.3 | | | 99,585 | |
| Bldg. 1029 Cooling Tower Fans | | | | | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | | | 32,943 | |
| Bldg. 1029 CHW Pump | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 82,138 | |
| Bldg. 1029 CW Pump | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 82,138 | |
| Bldg. 1029 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1000 Fan | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 20.1 | 176,076 | |
| Bldg. 1000 Fan | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 113,880 | |
| Bldg. 1000 Fan | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 20.5 | 179,580 | |
| Bldg. 1000 Fan | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 261,048 | |
| Bldg. 1000 Fan | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Bldg. 1000 Fan | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 19,272 | |
| Bldg. 1001 Fan | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Bldg. 1001 Fan | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 16.8 | 49,457 | |
| Bldg. 1029 Fan | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 50,933 | |
| Bldg. 1000 Boiler | | | | | | | | | | | | | | 10,809 |
| Bldg. 1000 HW Pump | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 162,936 | |
| Blodg. 1000 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1,095 | |
| Bldg. 1000 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 1000 HW Pump | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | |
| Bldg. 1000 HW Controls | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | |

1000 AREA

| ITEM | ECO G - INSTALL EMS AIRSIDE SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1000 LPS Boiler | | | | | | | | | | | | | | 2,591 |
| Bldg. 1000 LPS Boiler Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 1001 LPS Boiler | | | | | | | | | | | | | | 149 |
| Bldg. 1001 LPS Boiler Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 281 | |
| Bldg. 1029 Boiler | | | | | | | | | | | | | | 198 |
| Bldg. 1029 HW Pump | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 3,379 | |
| Bldg. 1029 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 192 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 323.0 | 293.6 | 647.6 | 695.9 | 920.2 | 980.4 | 1008.4 | 1033.4 | 968.9 | 851.2 | 664.4 | 333.0 | 4,685,391 | 13,747 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 2,423 | 2,202 | 4,857 | 5,219 | 6,902 | 9,804 | 10,084 | 10,334 | 9,689 | 6,384 | 4,983 | 2,498 | | |

| | | |
|---|---|---|
| Total Demand | 75,378 $/yr | |
| Demand Savings | 149 $/yr | |
| Energy Savings | 832 MMBTU/yr | (electric) |
| Energy Savings | -94 MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| **LOCATION:** FORT SAM HOUSTON , SAN ANTONIO,TX | **PROJECT NO:** 03-0185.06G | | **DATE:** 9/18/96 |
| **ECO NO. G AREA 1000** | **BY :** KOTHMANN, K | | **CHKD BY:** CARTER, J. |

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| EMCS COSTS BASED ON DDC ALL ELECTRIC | | | | | | | | |
| DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE | | | | | | | | |
| | | | | | | | | |
| DIGITAL OUTPUT DEVICE : | | | | | | | | |
| START-STOP MOTOR | 24 | EA | 10.2 | 28.91 | 7,077 | 175.74 | 4,218 | 11,295 |
| ENABLE/DISABLE APPARATUS RELAY | 13 | EA | 4.5 | 28.91 | 1,691 | 49.00 | 637 | 2,328 |
| ANALOG OUTPUT: | | | | | | | | |
| CONTROL VALVE (COIL/AHU ACTUATOR ONLY) | 24 | EA | 11.9 | 28.91 | 8,271 | 571.00 | 13,704 | 21,975 |
| DAMPER ACTUATOR & MOTOR | 30 | EA | 11.9 | 28.91 | 10,338 | 340.00 | 10,200 | 20,538 |
| DIGITAL INPUT: | | | | | | | | |
| DIFFERENTIAL PREASURE SWITCH | 11 | EA | 10.1 | 28.91 | 3,212 | 227.30 | 2,500 | 5,712 |
| AUXILIARY CONTACT | 10 | EA | 4.5 | 28.91 | 1,301 | 49.00 | 490 | 1,791 |
| | | | | | | | | |
| CURRENT SENSING RELAY | 24 | EA | 4.5 | 28.91 | 3,122 | 49.00 | 1,176 | 4,298 |
| | | | | | | | | |
| | | | | | | | | |
| SHEET 1 | | | | | | | | |
| | | | | SUBTOTAL | 35,012 | | 32,925 | 67,937 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO,TX | **PROJECT NO:** 03-0185.06G | **DATE:** 9/18/96

**ECO NO. G AREA 1000** | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| ANALOG INPUT: | | | | | | | | |
| TEMP. SENSER & THERMO WELL | 22 | EA | 17.0 | 28.91 | 10,812 | 426.42 | 9,381 | 20,194 |
| | | | | | | | | |
| TEMP. SENSER AIR DUCT | 31 | EA | 12.0 | 28.91 | 10,755 | 450.00 | 13,950 | 24,705 |
| TEMP. SENSER OUTSIDE AIR | 1 | EA | 12.0 | 28.91 | 347 | 550.00 | 550 | 897 |
| TEMP. SENSER ZONE | 19 | EA | 12.0 | 28.91 | 6,591 | 556.00 | 10,564 | 17,155 |
| RELATIVE HUMIDITY % | 1 | EA | 13.0 | 28.91 | 376 | 615.00 | 615 | 991 |
| AMPERES | 3 | EA | 7.0 | 28.91 | 607 | 219.00 | 657 | 1,264 |
| GAUGE PRESURE BOILER | 12 | EA | 8.0 | 28.91 | 2,775 | 197.00 | 2,364 | 5,139 |
| FLOW STATUS / RATE | 7 | EA | 17.0 | 28.91 | 3,440 | 410.00 | 2,870 | 6,310 |
| | | | | | | | | |
| | | | | | | | | |
| EQUIPMENT FAILURE ALARM | 13 | EA | 2.6 | 28.91 | 977 | 108.00 | 1,404 | 2,381 |
| FILTER ALARM | 11 | EA | 4.5 | 28.91 | 1,431 | 227.00 | 2,497 | 3,928 |
| HIGH & LOW LIMIT (HYDRONIC) | 49 | PR | 2.0 | 28.91 | 2,833 | 170.00 | 8,330 | 11,163 |
| SHEET 2 | | | | | | | | |
| | | | | SUBTOTAL | 40,945 | | 53,182 | 94,127 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX | PROJECT NO: 03-0185.06G | DATE: 9/18/96 |
| ECO NO. G AREA 1000 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| OPERATORS' WORKSTATION | 1 | SUM | | | | 13,184.00 | 13,184 | 13,184 |
| INCLUDING MODEM & REMOTE PANEL | | | | | | | | |
| SUBMITTALS, TRAINING & START-UP | 1 | JOB | | | | 8,300.00 | 8,300 | 8,300 |
| SOFTWARE | 1 | LS | | | | 15,000.00 | 15,000 | 15,000 |
| SUB TOTAL FROM SHEET 1 | | | | | 35,012 | | 32,925 | 67,937 |
| SUB TOTAL FROM SHEET 2 | | | | | 40,945 | | 53,182 | 94,127 |
| | | | | SUBTOTAL | 75,958 | | 122,591 | 198,549 |
| | | | | O & P @ 20% | 15,192 | | 24,518 | 39,710 |
| | | | | SUBTOTAL | 91,149 | | 147,110 | 238,259 |
| | | | | DESIGN @ 6% | | | | 14,296 |
| | | | | SUBTOTAL | | | | 252,554 |
| | | | | SIOH @ 5.5% | | | | 13,890 |
| | | | | TOTAL | | | | $266,445 |


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Life Cycle Cost Analysis — Study: FSH-2.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: FORT SAM HOUSTON

Region data: TEXAS — Census Region: 3

Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY

Fiscal Year: 1996 Discrete Portion: ECO-G

Analysis Date: 09/20/96 Economic Life: 20 years

Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $238,259 |
| B. SIOH | $13,890 |
| C. Design Cost | $14,296 |
| D. Total Cost (1A+1B+1C) | $266,445 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $266,445 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 832 | Mbtus | $5,225 | 15.08 | $78,792 |
| Elec. Deman | | | | | $149 | 14.88 | $2,217 |
| Natural Gas | $3.5 | /Mbtus | -94 | Mbtus | -$325 | 18.58 | -$6,043 |
| TOTAL | | | 738 | Mbtus | $5,049 | | $74,967 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $5,049 |
| 5. Simple Payback Period (Years) | 52.77 |
| 6. Total Net Discounted Savings | $74,967 |
| 7. Savings to Investment Ratio | .28 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | -3.33% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | H |
| DATE: | 3/1/96 |
| ECO TITLE: | Retrofit Existing Individual Chillers With Central Chillers |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 1000, buildings 1000, 1001, 1029, 1088 |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 1016 | MMBTU/yr |
| Electrical Demand Savings | 3865 | $/yr |
| Gas Energy Savings | 0 | MMBTU/yr |
| Total Energy Savings | 1016 | MMBTU/yr |
| Total Cost Savings | 37,885 | $/yr |
| Total Investment | 480,090 | $ |
| Simple Payback | 12.7 | yrs |
| SIR | 1.18 | |

A. ECO Description:

Remove the existing 160 ton chiller (120 GPM) from Building 1029. The two 400 ton chillers located in Building 1000's central cooling plant and the chiller serving Building 1001 (located in Building 1002) will remain. This plant serving Building 1000 is located on the North side of the building in building 1088. A section of the west wall of building 1088 will be removed and approximately 500 additional sq ft. will be added to this plant. A new chiller and pump pads will be constructed to install a new R-123, 315 ton water cooled centrifugal chiller with 0.57 KW/ton efficiency. The two existing CHW pumps will remain but they will need to have the impeller retrofitted to the next size up (if possible). The two CW pumps will remain as is. Install one 30 HP CHW pump selected at 630 GPM and 110 ft. hd, and one 20 HP CW pump selected at 940 GPM and 60 ft. Hd. A new cooling tower with a 20 HP two speed motor will be installed to support the new chiller, and it will be installed on the roof of the new addition to the plant. These towers will be piped in such a way that they shall be capable of serving any of the three chillers. The new and existing 400 ton centrifugal chillers at the central plant will be retrofitted to the low pressure refrigerant (R-123). Provide 12" CHW supply and return headers for all three chillers. Provide a 4" take-off for building 1001, and the existing CHW system for Building 1001 will be connected to this primary CHW loop. Similarly, a 3" primary loop will be constructed and connected to the existing CHW system of Building 1029. Approximately 150 ft. of 5", 100 ft. of 4" and 450 ft of 3" piping for the over-head piping and 800 ft of 4" and 800 ft. of 3" under ground piping will be required for these loops. The existing CHW pumps for Buildings 1001, (1002 which is not included in this project, but its cooling is served by Building 1001 chiller) and 1029 will be reutilized as secondary CHW pumps. All AHU, CHW coil three way control valves will be converted to two way valves to minimize pumping energy. A 2.5" by-pass control valve will be installed in the plant between the CHW supply and return lines to maintain a minimum CHW differential pressure and flow through the system for safe operation of the chillers. Utilize existing controls for the existing chillers and pumps and install new controls and electrical services at Building 1000 to serve the new chiller and pumps. Other specific requirements should

be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment and installation of the new chiller, cooling tower, associated wiring and controls.

B. Discussion:

Building 1000 is served by two 400 ton water cooled centrifugal liquid chillers. Both were installed in 1993. They are in excellent condition. Although they are R-11 chillers, it is not cost effective to replace them. However, it is recommended to retrofit them with R-123 refrigerant. Currently, there is no more R-11 being manufactured in the United States. Even though the refrigerant is readily available, as time goes on; the supply of this refrigerant will become scarce and more expensive. At the time of this report, R-11 refrigerant is available for $9.00 per pound of refrigerant as opposed to $3.50 per pound for R-123 refrigerant. Moreover, many vendors are buying CFC refrigerant from owners to stockpile. As a result, there is a refrigerant reclaim cost of $2.00 per pound associated with this old refrigerant that was included in the life cycle cost analysis. In converting the chillers to an approved refrigerant, there is a reduction of 5% in the tonnage of the equipment, and a reduction of 3% in efficiency. This was included in the equipment simulation for the two existing chillers.

Building 1001 is served by a 219 ton centrifugal chiller, which was installed in 1974. The no-longer manufactured R-11 refrigerant, age, inefficiency, and added maintenance justify its removal. However, this chiller is located and also serves Building 1002 which is not included in the Scope of Work for this project; therefore, we will not include the replacement of this chiller in this ECO. Building 1029 is served by a new 160 ton, R-123 centrifugal chiller which was installed in 1995. All chiller auxiliaries except the cooling tower were also replaced at the same time. The chiller, CW pump and cooling tower will be removed and stored for future use. The CHW pump will be reutilized as a secondary CHW pump. All chillers are in different locations and are remote to each other. With the exception of the chiller serving Building 1001, all are in excellent condition. The primary factor for replacing these chillers with a central chiller plant is due to the added maintenance cost associated with maintaining multiple water cooled chillers and with the inefficiency of the older machines.

Therefore, it is recommended that a central chiller plant, consisting of a new 235 ton and two existing 400 ton water cooled chillers be installed to serve these buildings. The existing chiller plant for building 1000 does not have sufficient room to house a new chiller and its pumps and therefore it must be expanded. The only expansion possibility for this plant is on the west wall adjacent to the parking lot. Since the existing plant cooling towers are on the roof, the new cooling tower will be installed on roof of this new expansion. The chillers will be connected to the new CHW loops. All existing building CHW pumps will be reutilized as secondary pumps. With a CHW header configuration, under low cooling load conditions fewer chillers will operate. Particularly when Buildings 1001 and 1029 have very light occupancy during night hours. Only Building 1000, a hospital remains occupied after hours. Currently Building 1001's and 1029's chillers operate at low load conditions and are very inefficient at these low loads. A central cooling plant operation will eliminate this low load condition, operate fewer chillers at a higher load, and improve cooling efficiency. This will save energy and greatly reduce the maintenance cost of the installation.

Maintaining the accessibility for the emergency entrance and support service area behind the hospital poses a problem for construction and providing an underground primary CHW piping loop . Therefore a portion of the CHW supply and return piping will be constructed above

ground, alongside existing above ground piping, in the back of the hospital. The remainder of the piping can be installed under ground. Computer simulations of the buildings in this area determined that the current installed capacity of 1056 tons is more than required to adequately cool the buildings[1]. Therefore it is recommended that one new chiller and two existing chillers rated at a total of 995 tons be installed to more closely match the cooling load of the buildings.

Building 1001 is served by four AHUs with wild CHW coils. New two way CHW control valves will be installed on these coils. All other buildings AHU, CHW coil three way control valves will be converted to two way valves to minimize pumping energy and provide better distribution of CHW flow to the AHU coils.

C. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed chillers and pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3].

There were several types of chillers modeled including centrifugal, screw, variable speed driven centrifugal, and gas engine driven. Water cooled R-123 centrifugal machines are more efficient in their full load KW/ton ratings over the screw or gas engine driven machines, while the screw machines were approximately 10% more efficient in the part load range between 25% -50%. Full load performance data from York International was used in the computer simulations of the new chiller energy usage, while part load data was available from equipment supplied with Trace 600. Equipment lists of the specific chillers and pumps modeled for the proposed chiller alternatives are shown on pages C-128 Through C-134.

In this particular area, the proposed electric driven alternatives were modeled together with the already existing chillers. However, the gas engine chillers were selected to handle the entire load. The reason for this was to utilize the electric demand savings available, and because the gas engine chillers are more readily available at larger loads and have a history of being more economical at larger loads.

Once the computer simulations of the existing and new chiller plants were completed, the total annual demand cost and energy consumption of each chiller was compared with that of the existing chiller to determine the annual savings for this ECO. These savings calculations are shown on pages C-135 and C-137. These demand and energy savings values were used in the life cycle cost analysis. The results of these savings calculations were as follows:

| Alternative | Chiller Type | Demand Savings $/yr | Electrical Savings MMBTU/yr | Gas Savings MMBTU/yr |
|---|---|---|---|---|
| **H1** | Electric Centrifugal | 3865 | 1016 | 0 |
| **H2** | Electric Centrifugal & VFD | 2229 | 1118 | 0 |
| **H3** | Electric Screw | 2517 | 1012 | 0 |
| **H4** | Gas Driven Centrifugal | 47,597 | 8940 | -18260 |

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water cooled chillers in this area down to three water cooled chillers. The total maintenance cost savings from this ECO is estimated to be $27,480 per year as calculated on page C-156. This figure was used in the life cycle cost analysis.

D. Cost Estimates:

The total installation costs for the new central chiller plant were estimated on pages C-138 through C-155. These costs were used in the life cycle cost analysis. The results of the costs estimates were as follows:

| Alternative | Chiller Type | Estimated Cost |
|---|---|---|
| **H1** | Electric Centrifugal | $480,090 |
| **H2** | Electric Centrifugal & VFD | $491,707 |
| **H3** | Electric Screw | $494,282 |
| **H4** | Gas Driven Centrifugal | $1,872,481 |

E. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. An item for R-11 refrigerant reclaim cost was input into the program based on $2.00 per pound and 2 pound per ton of chillers. Also, in alternatives H1, H2, and H3 there was a salvage value of $8,000 associated with the one centrifugal chiller serving building 1029. This costs were obtained from Entech Sales and Service in Dallas, Texas. However, on alternative H4, the installation will save the cost of not having to retrofit the existing R-11 machines to R-123, so there was a one time savings of $50,000 for both chillers ($25,000 per chiller) serving building 1000 along with the salvage value of building 1029's chiller. The summary sheets for the life cycle cost analysis of

each alternative are shown on pages C-157 through C-160. The results of the alternative life cycle cost analysis were as follows:

| Alternative | Chiller Type | Payback Years | SIR |
|---|---|---|---|
| **H1** | Electric Centrifugal | 12.7 | 1.18 |
| **H2** | Electric Centrifugal & VFD | 13.3 | 1.12 |
| **H3** | Electric Screw | 13.5 | 1.10 |
| **H4** | Gas Driven Centrifugal | 26.5 | 0.45 |

Since the electric centrifugal chiller has the highest SIR, it is recommended as the most economical choice to replace the existing machine. The data from the life cycle cost analysis for this alternative were included in the summary on page C-123.

## REFERENCES

1. Refer to Appendix H for the system thermal load profile for this area.
2. Refer to Appendix H for the computer modeling input assumptions, data, and consumption output.
3. Refer to Appendix G for building field data and existing HVAC equipment data.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H1, FORT SAM HOUSTON, AREA 1000

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller CH-1 | 1 | York YT<br>water cooled, centrifugal,<br>235 tons, R-123 | Area 1000 | New | 141 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>470 gpm, 110 ft<br>20 HP | Area 1000 | New | 14.90 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>705 gpm, 60 ft<br>15 HP | Area 1000 | New | 11.20 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>15 HP fan | Area 1000 | New | 11.20 KW |
| Water Chiller CH-2 | 1 | York (centrifugal)<br># YTG3H3E1CND, R-123<br>380 tons | Currently serves bldg. 1000, retrofit to R-123 | 1993 | 260 KW |
| Chilled Water Pump | 1 | TACO, 50 HP<br>960 GPM, 110 ft head<br>50 HP | Currently serves bldg. 1000 CH-1 increase impeller to next size up | 1993 | 37.29 KW |
| Cond. Water Pump | 1 | TACO, 40 HP<br>1132 GPM, 66 ft head | Currently serves bldg. 1000 CH-1 | 1993 | 29.83 KW |
| Cooling Tower | 1 | Marley, 25 HP<br>single speed motor | Bldg. 1000 (CH-1) | 1993 | 18.64 KW |
| Water Chiller CH-3 | 1 | York (centrifugal)<br># YTG3H3E1CND, R-123<br>380 tons | Currently serves bldg. 1000, retrofit to R-123 | 1993 | 286 KW |
| Chilled Water Pump | 1 | TACO, 50 HP<br>960 GPM, 110 ft head | Currently serves bldg. 1000 CH-1 increase impeller to next size up | 1993 | 37.29 KW |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H1, FORT SAM HOUSTON, AREA 1000

MARCH 1, 1996

| | | | | | |
|---|---|---|---|---|---|
| Cond. Water Pump | 1 | TACO, 40 HP<br>1132 GPM, 66 ft head | Currently serves bldg. 1000<br>CH-1 | 1993 | 29.83 KW |
| Cooling Tower | 1 | Marley, 25 HP<br>single speed motor | Bldg. 1000 (CH-2) | 1993 | 18.64 KW |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H2, FORT SAM HOUSTON, AREA 1000

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller CH-1 | 1 | York YT with VFD<br>water cooled, centrifugal,<br>235 tons, R-123 | Area 1000 | New | 141 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>470 gpm, 110 ft<br>20 HP | Area 1000 | New | 14.90 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>705 gpm, 60 ft<br>15 HP | Area 1000 | New | 11.20 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>15 HP fan | Area 1000 | New | 11.20 KW |
| Water Chiller CH-2 | 1 | York (centrifugal)<br># YTG3H3E1CND, R-123<br>380 tons | Currently serves bldg. 1000, retrofit to R-123 | 1993 | 260 KW |
| Chilled Water Pump | 1 | TACO, 50 HP<br>960 GPM, 110 ft head<br>50 HP | Currently serves bldg. 1000 CH-1 increase impeller to next size up | 1993 | 37.29 KW |
| Cond. Water Pump | 1 | TACO, 40 HP<br>1132 GPM, 66 ft head | Currently serves bldg. 1000 CH-1 | 1993 | 29.83 KW |
| Cooling Tower | 1 | Marley, 25 HP<br>single speed motor | Bldg. 1000 (CH-1) | 1993 | 18.64 KW |
| Water Chiller CH-3 | 1 | York (centrifugal)<br># YTG3H3E1CND, R-123<br>380 tons | Currently serves bldg. 1000, retrofit to R-123 | 1993 | 286 KW |
| Chilled Water Pump | 1 | TACO, 50 HP<br>960 GPM, 110 ft head | Currently serves bldg. 1000 CH-1 increase impeller to next size up | 1993 | 37.29 KW |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H2, FORT SAM HOUSTON, AREA 1000

MARCH 1, 1996

| | | | | | |
|---|---|---|---|---|---|
| Cond. Water Pump | 1 | TACO, 40 HP<br>1132 GPM, 66 ft head | Currently serves bldg. 1000<br>CH-1 | 1993 | 29.83 KW |
| Cooling Tower | 1 | Marley, 25 HP<br>single speed motor | Bldg. 1000 (CH-2) | 1993 | 18.64 KW |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H3, FORT SAM HOUSTON, AREA 1000

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller CH-1 | 1 | York YS<br>water cooled screw<br>235 tons, R-123 | Area 1000 | New | 146 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>470 gpm, 110 ft<br>20 HP | Area 1000 | New | 14.90 KW |
| Condenser Water Pump | 1 | Bell & Gossett<br>705 gpm, 60 ft<br>15 HP | Area 1000 | New | 11.20 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, induced draft<br>15 HP fan | Area 1000 | New | 11.20 KW |
| Water Chiller CH-2 | 1 | York (centrifugal)<br># YTG3H3E1CND, R-123<br>380 tons | Currently serves bldg. 1000, retrofit to R-123 | 1993 | 260 KW |
| Chilled Water Pump | 1 | TACO, 50 HP<br>960 GPM, 110 ft head<br>50 HP | Currently serves bldg. 1000 CH-1 increase impeller to next size up | 1993 | 37.29 KW |
| Cond. Water Pump | 1 | TACO, 40 HP<br>1132 GPM, 66 ft head | Currently serves bldg. 1000 CH-1 | 1993 | 29.83 KW |
| Cooling Tower | 1 | Marley, 25 HP<br>single speed motor | Bldg. 1000 (CH-1) | 1993 | 18.64 KW |
| Water Chiller CH-3 | 1 | York (centrifugal)<br># YTG3H3E1CND, R-123<br>380 tons | Currently serves bldg. 1000, retrofit to R-123 | 1993 | 286 KW |
| Chilled Water Pump | 1 | TACO, 50 HP<br>960 GPM, 110 ft head | Currently serves bldg. 1000 CH-1 increase impeller to next size up | 1993 | 37.29 KW |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H3, FORT SAM HOUSTON, AREA 1000

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Cond. Water Pump | 1 | TACO, 40 HP<br>1132 GPM, 66 ft head | Currently serves bldg. 1000<br>CH-1 | 1993 | 29.83 KW |
| Cooling Tower | 1 | Marley, 25 HP<br>single speed motor | Bldg. 1000 (CH-2) | 1993 | 18.64 KW |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-H4, FORT SAM HOUSTON, AREA 1000

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 2 | York, gas engine driven YG<br>water cooled, centrifugal<br>500 tons, R-134a | Area 1000 | New | 3,284 MBH |
| Chilled Water Pump | 2 | Bell & Gossett<br>1000 gpm, 110 ft<br>40 HP | Area 1000 | New | 29.80 KW |
| Condenser Water Pump | 2 | Bell & Gossett<br>1650 gpm, 60 ft<br>30 HP | Area 1000 | New | 22.40 KW |
| Cooling Tower | 2 | Evapco AT<br>crossflow, induced draft<br>25 HP fan | Area 1000 | New | 18.60 KW |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

## 1000 AREA

| ITEM | ECO H - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1000 Chiller (CHLR-1) | 90.5 | 57.9 | 203.2 | 208.4 | 185.3 | 212.4 | 223.3 | 233.8 | 206.8 | 213.1 | 212.1 | 99.5 | 994,677 | |
| Bldg. 1000 Cooling Tower Fans | 11.4 | 2.8 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 13.7 | 106,916 | |
| Bldg. 1000 CHW Pump | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 326,748 | |
| Bldg. 1000 CND Pump | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 261,048 | |
| Bldg. 1000 CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 8,760 | |
| Bldg. 1000 Chiller (CHLR-2) | | | 120.6 | 163.1 | 203.7 | 233.5 | 245.4 | 256.9 | 227.3 | 146.9 | 127.9 | | 897,779 | |
| Bldg. 1000 Cooling Tower Fans | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | 93,878 | |
| Bldg. 1000 CHW Pump | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | 188,738 | |
| Bldg. 1000 CND Pump | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | 150,788 | |
| Bldg. 1000 CHW Controls | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | 5,060 | |
| Bldg. 1001 Window Units | 6.4 | 6.4 | 6.4 | 6.7 | 7.2 | 7.5 | 7.7 | 7.7 | 7.2 | 6.7 | 6.4 | 6.4 | 10,623 | |
| Bldg. 1001 Window Unit Fans | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.8 | 1.0 | 1.0 | 0.7 | 0.6 | 0.0 | 0.0 | 1,412 | |
| Bldg. 1001 Window Unit Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 876 | |
| Bldg. 1001 Chiller | | | | | 60.1 | 61.2 | 63.8 | 63.9 | 57.6 | 40.6 | | | 121,332 | |
| Bldg. 1001 Cooling Tower Fans | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 45,605 | |
| Bldg. 1001 CND Pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 1001 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1029 Chiller | | | | | 62.2 | 62.7 | 65.8 | 68.1 | 64.7 | 49.6 | | | 115,128 | |
| Bldg. 1029 Cooling Tower Fans | | | | | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | | | 30,036 | |
| Bldg. 1029 CND Pump | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 82,138 | |
| Bldg. 1029 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| | | | | | | | | | | | | | | |
| Totals | 176.5 | 135.3 | 503.7 | 551.7 | 743.2 | 802.1 | 831.0 | 855.4 | 788.3 | 681.5 | 519.9 | 187.8 | 3,499,833 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 1,324 | 1,015 | 3,778 | 4,138 | 5,574 | 8,021 | 8,310 | 8,554 | 7,883 | 5,111 | 3,899 | 1,409 | | |

Total Demand 59,015 $/yr

Total Energy 11,945 MMBTU/yr (electric)

Total Energy MMBTU/yr (gas)

## 1000 AREA

| ITEM | ECO-H1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller # 1 | 86.9 | 49.8 | 112..4 | 113.9 | 122.7 | 122.2 | 126.1 | 131.7 | 128.0 | 119.5 | 96.7 | 100.5 | 627,525 | |
| Cooling Tower Fans | 10.2 | 6.4 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 69,469 | |
| CHW Pump | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 130,524 | |
| CND Pump | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 98,112 | |
| CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 8,760 | |
| Water Chiller # 2 | | | 155.3 | 214.3 | 230.7 | 229.5 | 233.2 | 242.9 | 240.1 | 226.7 | 165.3 | | 930,753 | |
| Cooling Tower Fans | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | 98,040 | |
| CHW Pump | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | 197,130 | |
| CND Pump | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | 157,493 | |
| CHW Controls | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | 5,285 | |
| Water Chiller # 3 | | | | | 214.7 | 228.3 | 256.6 | 267.2 | 238.0 | 161.1 | | | 604,890 | |
| Cooling Tower Fans | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 58,813 | |
| CHW Pump | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 117,943 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 94,228 | |
| CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,162 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 124.2 | 83.3 | 280.3 | 453.2 | 779.8 | 791.7 | 827.6 | 853.5 | 817.8 | 719.0 | 387.0 | 138.8 | 3,202,127 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 932 | 625 | 2,102 | 3,399 | 5,849 | 7,917 | 8,276 | 8,535 | 8,178 | 5,393 | 2,903 | 1,041 | | |

| | | |
|---|---|---|
| Total Demand | 55,150 $/yr | |
| Demand Savings | 3,865 $/yr | |
| Energy Savings | 1,016 MMBTU/yr | (electric) |
| Energy Savings | MMBTU/yr | (gas) |

| ITEM | ECO-H2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller # 1 | 102.9 | 53.7 | 139.4 | 120.3 | 135.0 | 134.5 | 121.0 | 126.9 | 141.0 | 140.7 | 111.7 | 120.9 | 635,507 | |
| Cooling Tower Fans | 8.0 | 3.9 | 8.6 | 6.5 | 6.8 | 8.1 | 9.8 | 10.5 | 8.7 | 7.9 | 7.1 | 8.3 | 31,563 | |
| CHW Pump | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 130,524 | |
| CND Pump | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 98,112 | |
| CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 8,760 | |
| Water Chiller # 2 | | | 155.3 | 214.3 | 230.7 | 229.5 | 233.2 | 242.9 | 240.1 | 226.7 | 165.3 | | 930,753 | |
| Cooling Tower Fans | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | 98,040 | |
| CHW Pump | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | 197,130 | |
| CND Pump | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | 157,493 | |
| CHW Controls | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | 5,285 | |
| Water Chiller # 3 | | | | | 214.7 | 228.3 | 256.6 | 267.2 | 238.0 | 161.1 | | | 604,890 | |
| Cooling Tower Fans | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 58,813 | |
| CHW Pump | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 117,943 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 94,228 | |
| CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,162 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 138.0 | 84.7 | 417.1 | 454.9 | 787.7 | 800.9 | 821.1 | 848.0 | 828.3 | 736.9 | 397.9 | 156.3 | 3,172,203 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 1,035 | 635 | 3,128 | 3,412 | 5,908 | 8,009 | 8,211 | 8,480 | 8,283 | 5,527 | 2,984 | 1,172 | | |

| | | |
|---|---|---|
| Total Demand | 56,786 $/yr | |
| Demand Savings | 2,229 $/yr | |
| Energy Savings | 1,118 MMBTU/yr | (electric) |
| Energy Savings | MMBTU/yr | (gas) |

| ITEM | ECO-H3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller # 1 | 91.9 | 47.1 | 119.6 | 119.3 | 128.5 | 127.9 | 130.7 | 136.3 | 133.8 | 125.9 | 102.6 | 107.4 | 628,893 | |
| Cooling Tower Fans | 10.2 | 6.3 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 69,432 | |
| CHW Pump | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 130,524 | |
| CND Pump | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 98,112 | |
| CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 8,760 | |
| Water Chiller # 2 | | | 155.3 | 214.3 | 230.7 | 229.5 | 233.2 | 242.9 | 240.1 | 226.7 | 165.3 | | 930,753 | |
| Cooling Tower Fans | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | 98,040 | |
| CHW Pump | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | 197,130 | |
| CND Pump | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | 157,493 | |
| CHW Controls | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | 5,285 | |
| Water Chiller # 3 | | | | | 214.7 | 228.3 | 256.6 | 267.2 | 238.0 | 161.1 | | | 604,890 | |
| Cooling Tower Fans | | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 58,813 | |
| CHW Pump | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 117,943 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 94,228 | |
| CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 3,162 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 129.2 | 80.5 | 399.9 | 458.6 | 785.6 | 797.4 | 832.2 | 858.1 | 823.6 | 725.4 | 392.9 | 145.7 | 3,203,458 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 969 | 604 | 2,999 | 3,440 | 5,892 | 7,974 | 8,322 | 8,581 | 8,236 | 5,441 | 2,947 | 1,093 | | |

Total Demand 56,498 $/yr
Demand Savings 2,517 $/yr
Energy Savings 1,012 MMBTU/yr (electric)
Energy Savings MMBTU/yr (gas)

| ITEM | ECO-H4: NEW GAS ENGINE DRIVEN CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller # 1 | | | | | | | | | | | | | | 10,985 |
| Cooling Tower Fans | 9.2 | 1.7 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 11.6 | 105,997 | |
| CHW Pump | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 261,048 | |
| CND Pump | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 196,224 | |
| CHW Controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 8,760 | |
| Water Chiller # 2 | | | | | | | | | | | | | | 7,275 |
| Cooling Tower Fans | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | 79,924 | |
| CHW Pump | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 128,051 | |
| CND Pump | | | | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | | | 96,253 | |
| CHW Controls | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,297 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 62.4 | 54.9 | 71.8 | 143.6 | 143.6 | 143.6 | 143.6 | 143.6 | 143.6 | 143.6 | 71.8 | 64.8 | 880,554 | 18,260 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 468 | 412 | 539 | 1,077 | 1,077 | 1,436 | 1,436 | 1,436 | 1,436 | 1,077 | 539 | 486 | | |

Total Demand 11,418 $/yr
Demand Savings 47,597 $/yr
Energy Savings 8,940 MMBTU/yr (electric)
Energy Savings -18,260 MMBTU/yr (gas)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-0185.6H1

**DATE:** 9/18/96

**ECO NO. H-1** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMY CHILLER | 379 | TON | 1.5 | 28.91 | 16,874 | 25.00 | 9,475 | 26,349 |
| RMN COOLING TOWER | 2 | EA | 150.0 | 28.91 | 8,673 | 1,900.00 | 3,800 | 12,473 |
| DISCOUNT FOR SALVAGE | 1 | EA | | | | | | -8,000 |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 4" | 800 | LF | 0.8 | 28.91 | 17,346 | 19.55 | 15,640 | 32,986 |
| 3" | 800 | LF | 0.6 | 28.91 | 13,877 | 15.70 | 12,560 | 26,437 |
| | | | | SUBTOTAL | 56,769 | | 41,475 | 90,244 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6H1
**DATE:** 9/18/96

**ECO NO. H-1** Retrofit Existing Individual Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 2 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 1 | LOC | 10.7 | 28.91 | 308 | 717.00 | 717 | 1,025 |
| CHANGEALL AHU EQUIPMENT CONTROL VALVE | 1 | JOB | 64.0 | 28.91 | 1,850 | 8,000.00 | 8,000 | 9,850 |
| PIPING ASSEMBLY & ELECTRICAL | | | | | | | | |
| SUBTOTAL | | | | | 5,009 | | 12,252 | 17,261 |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| TOTAL | | | | | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-1 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H1 | DATE: 9/18/96

BY : KOTHMANN, K | CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| CONSTRUCT CENTRAL PLANT BASE BUILDING | 500 | BSF | | | | 80.00 | 40,000 | 40,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 500 | BSF | | | | 34.00 | 17,000 | 17,000 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 235 | TON | 3.2 | 28.91 | 21,740 | 371.00 | 87,185 | 108,925 |
| PRIMARY PUMPS 20 HP | 1 | EA | 22.0 | 28.91 | 636 | 3,900.00 | 3,900 | 4,536 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 235 | TON | 0.6 | 28.91 | 4,076 | 92.00 | 21,620 | 25,696 |
| MODIFY EXISTING CHW PUMPS | 2 | EA | 12.0 | 28.91 | 694 | 300.00 | 600 | 1,294 |
| 12" CHILLER PLANT MANIFOLD & VALVES | 1 | JOB | 133.0 | 28.91 | 3,845 | 9,600.00 | 9,600 | 13,445 |
| CENTRAL PLANT CONTROLS | 1 | JOB | 300.0 | 28.91 | 8,673 | 6,000.00 | 6,000 | 14,673 |
| | | | | SUBTOTAL | 39,665 | | 185,905 | 225,570 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO.** H-1 Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6H1

**DATE:** 9/18/96

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 5" | 150 | LF | .82 | 28.91 | 3,556 | 24.25 | 3,638 | 7,193 |
| 4" | 100 | LF | .64 | 28.91 | 1,850 | 15.05 | 1,505 | 3,355 |
| 3" | 450 | LF | .57 | 28.91 | 7,415 | 10.39 | 4,676 | 12,091 |
| | | | | SUBTOTAL | 12,822 | | 9,818 | 22,640 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-1 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H1

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 56,769 | | 41,475 | 98,244 |
| SUB TOTAL FROM SHEET 2 | | | | | 5,009 | | 12,252 | 17,261 |
| SUB TOTAL FROM SHEET 3 | | | | | 39,665 | | 185,905 | 225,570 |
| SUB TOTAL FROM SHEET 4 | | | | | 12,822 | | 9,818 | 22,640 |
| | | | | SUBTOTAL | 114,265 | | 249,450 | 363,715 |
| | | | | O & P @ 20% | 22,853 | | 49,890 | 72,743 |
| | | | | SUBTOTAL | 137,118 | | 299,340 | 436,458 |
| | | | | DESIGN @ 6% | | | | 26,187 |
| | | | | SUBTOTAL | | | | 462,645 |
| | | | | SIOH @ 5.5% | | | | 25,445 |
| | | | | TOTAL | | | | $488,091 |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO.** H-2 Retrofit Existing Individual Chillers

**PROJECT NO:** 03-0185.6H2

**DATE:** 9/18/96

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 379 | TON | 1.5 | 28.91 | 16,874 | 25.00 | 9,475 | 26,349 |
| RMN COOLING TOWER | 2 | EA | 150.0 | 28.91 | 8,673 | 1,900.00 | 3,800 | 12,473 |
| DISCOUNT FOR SALVAGE | 1 | EA | | | | | | -8,000 |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 4" | 800 | LF | 0.8 | 28.91 | 17,346 | 19.55 | 15,640 | 32,986 |
| 3" | 800 | LF | 0.6 | 28.91 | 13,877 | 15.70 | 12,560 | 26,437 |
| SUBTOTAL | | | | | 56,769 | | 41,475 | 90,244 |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| TOTAL | | | | | | | | |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-2 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H2 DATE: 9/18/96

BY : KOTHMANN, K CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 1 | LOC | 10.7 | 28.91 | 308 | 717.00 | 717 | 1,025 |
| CHANGEALL AHU EQUIPMENT CONTROL VALVE | 1 | JOB | 64.0 | 28.91 | 1,850 | 8,000.00 | 8,000 | 9,850 |
| PIPING ASSEMBLY & ELECTRICAL | | | | | | | | |
| | | | | SUBTOTAL | 5,009 | | 12,252 | 17,261 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-2 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H2

DATE: 9/18/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| CONSTRUCT CENTRAL PLANT BASE BUILDING | 500 | BSF | | | | 80.00 | 40,000 | 40,000 |
| HISTORICLY COMPATABLE | | | | | | | | |
| CENTRAL PLANT ELECTRICAL SYSTEM | 500 | BSF | | | | 34.00 | 17,000 | 17,000 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 235 | TON | 3.2 | 28.91 | 21,740 | 371.00 | 87,185 | 108,925 |
| ADD FOR VFD | 50 | HP | 0.8 | 28.91 | 1,156 | 150.00 | 7,500 | 8,656 |
| PRIMARY PUMPS 20 HP | 1 | EA | 22.0 | 28.91 | 636 | 3,900.00 | 3,900 | 4,536 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 235 | TON | 0.6 | 28.91 | 4,076 | 92.00 | 21,620 | 25,696 |
| MODIFY EXISTING CHW PUMPS | 2 | EA | 12.0 | 28.91 | 694 | 300.00 | 600 | 1,294 |
| 12" CHILLER PLANT MANIFOLD & VALVES | 1 | JOB | 133.0 | 28.91 | 3,845 | 9,600.00 | 9,600 | 13,445 |
| CENTRAL PLANT CONTROLS | 1 | JOB | 300.0 | 28.91 | 8,673 | 6,000.00 | 6,000 | 14,673 |
| | | | | SUBTOTAL | 40,821 | | 193,405 | 234,226 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

512 MAIN STREET, SUITE 1500

FORT WORTH, TEXAS 76102-3922

(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-185.6H2

DATE: 9/18/96

ECO NO. H-2 Retrofit Existing Individual Chillers

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 5" | 150 | LF | .82 | 28.91 | 3,556 | 24.25 | 3,638 | 7,193 |
| 4" | 100 | LF | .64 | 28.91 | 1,850 | 15.05 | 1,505 | 3,355 |
| 3" | 450 | LF | .57 | 28.91 | 7,415 | 10.39 | 4,676 | 12,091 |
| | | | | SUBTOTAL | 12,822 | | 9,818 | 22,640 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
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512 MAIN STREET, SUITE 1500
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6H2
**DATE:** 9/18/96

**ECO NO. H-2** Retrofit Existing Individual Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 56,769 | | 41,475 | 98,244 |
| SUB TOTAL FROM SHEET 2 | | | | | 5,009 | | 12,252 | 17,261 |
| SUB TOTAL FROM SHEET 3 | | | | | 40,821 | | 193,405 | 234,226 |
| SUB TOTAL FROM SHEET 4 | | | | | 12,822 | | 9,818 | 22,640 |
| SUBTOTAL | | | | | 115,421 | | 256,950 | 372,371 |
| O & P @ 20% | | | | | 23,084 | | 51,390 | 74,474 |
| SUBTOTAL | | | | | 138,505 | | 308,340 | 446,845 |
| DESIGN @ 6% | | | | | | | | 26,811 |
| SUBTOTAL | | | | | | | | 473,656 |
| SIOH @ 5.5% | | | | | | | | 26,051 |
| TOTAL | | | | | | | | $499,707 |

**HUITT-ZOLLARS, INC.**
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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. H-3** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-0185.6H3

**DATE:** 9/18/96

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 379 | TON | 1.5 | 28.91 | 16,874 | 25.00 | 9,475 | 26,349 |
| RMV COOLING TOWER | 2 | EA | 150.0 | 28.91 | 8,673 | 1,900.00 | 3,800 | 12,473 |
| DISCOUNT FOR SALVAGE | 1 | EA | | | | | | -8,000 |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 4" | 800 | LF | 0.8 | 28.91 | 17,346 | 19.55 | 15,640 | 32,986 |
| 3" | 800 | LF | 0.6 | 28.91 | 13,877 | 15.70 | 12,560 | 26,437 |
| | | | | SUBTOTAL | 56,769 | | 41,475 | 90,244 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6H3

**DATE:** 9/18/96

**ECO NO. H-3** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 1 | LOC | 10.7 | 28.91 | 308 | 717.00 | 717 | 1,025 |
| CHANGEALL AHU EQUIPMENT CONTROL VALVE | 1 | JOB | 64.0 | 28.91 | 1,850 | 8,000.00 | 8,000 | 9,850 |
| PIPING ASSEMBLY & ELECTRICAL | | | | | | | | |
| | | | | SUBTOTAL | 5,009 | | 12,252 | 17,261 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6H3 **DATE:** 9/18/96

**ECO NO. H-3** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| CONSTRUCT CENTRAL PLANT BASE BUILDING | 500 | BSF | | | | 80.00 | 40,000 | 40,000 |
| HISTORICLY COMPATABLE | | | | | | | | |
| CENTRAL PLANT ELECTRICAL SYSTEM | 500 | BSF | | | | 34.00 | 17,000 | 17,000 |
| CHILLER (YORK YS) WITH PIPING & VESELS | 235 | TON | 3.2 | 28.91 | 21,740 | 416.00 | 97,760 | 119,500 |
| PRIMARY PUMPS 20 HP | 1 | EA | 22.0 | 28.91 | 636 | 3,900.00 | 3,900 | 4,536 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 235 | TON | 0.6 | 28.91 | 4,076 | 92.00 | 21,620 | 25,696 |
| MODIFY EXISTING CHW PUMPS | 2 | EA | 12.0 | 28.91 | 694 | 300.00 | 600 | 1,294 |
| 12" CHILLER PLANT MANIFOLD & VALVES | 1 | JOB | 133.0 | 28.91 | 3,845 | 9,600.00 | 9,600 | 13,445 |
| CENTRAL PLANT CONTROLS | 1 | JOB | 300.0 | 28.91 | 8,673 | 6,000.00 | 6,000 | 14,673 |
| | | | | SUBTOTAL | 39,665 | | 196,480 | 236,145 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-3 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H3

DATE: 9/18/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 5" | 150 | LF | .82 | 28.91 | 3,556 | 24.25 | 3,638 | 7,193 |
| 4" | 100 | LF | .64 | 28.91 | 1,850 | 15.05 | 1,505 | 3,355 |
| 3" | 450 | LF | .57 | 28.91 | 7,415 | 10.39 | 4,676 | 12,091 |
| | | | | SUBTOTAL | 12,822 | | 9,818 | 22,640 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-3 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H3

DATE: 9/18/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: NEW Central Plant and HVAC Equipment WATER COOLED SCREW R-123
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 56,769 | | 41,475 | 98,244 |
| SUB TOTAL FROM SHEET 2 | | | | | 5,009 | | 12,252 | 17,261 |
| SUB TOTAL FROM SHEET 3 | | | | | 39,665 | | 196,480 | 236,145 |
| SUB TOTAL FROM SHEET 4 | | | | | 12,822 | | 9,818 | 22,640 |
| | | | | SUBTOTAL | 114,265 | | 260,025 | 374,290 |
| | | | | O & P @ 20% | 22,853 | | 52,005 | 74,858 |
| | | | | SUBTOTAL | 137,118 | | 312,030 | 449,148 |
| | | | | DESIGN @ 6% | | | | 26,949 |
| | | | | SUBTOTAL | | | | 476,096 |
| | | | | SIOH @ 5.5% | | | | 26,185 |
| | | | | TOTAL | | | | $502,282 |

**HUITT-ZOLLARS, INC.**
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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-4 Retrofit Existing Individual Chillers

PROJECT NO: 03-0185.6H4

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant GAS ENGINE DRIVEN R-134a
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 1,179 | TON | 1.1 | 28.91 | 37,493 | 20.00 | 23,580 | 61,073 |
| RMV COOLING TOWER | 3 | EA | 120.0 | 28.91 | 10,408 | 1,900.00 | 5,700 | 16,108 |
| DISCOUNT FOR SALVAGE | 1 | EA | | | | | | -8,000 |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 4" | 800 | LF | 0.8 | 28.91 | 17,346 | 19.55 | 15,640 | 32,986 |
| 3" | 800 | LF | 0.6 | 28.91 | 13,877 | 15.70 | 12,560 | 26,437 |
| | | | | SUBTOTAL | 79,124 | | 57,480 | 128,604 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. H-4** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6H4 **DATE:** 9/18/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant GAS ENGINE DRIVEN R-134a
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 1 | LOC | 10.7 | 28.91 | 308 | 717.00 | 717 | 1,025 |
| 8" | 1 | LOC | 30.0 | 28.91 | 867 | 1,900.00 | 1,900 | 2,767 |
| CHANGE ALL AHU EQUIPMENT CONTROL VALVES | 1 | JOB | 64.0 | 28.91 | 1,850 | 8,000.00 | 8,000 | 9,850 |
| PIPING ASSEMBLY & ELECTRICAL | | | | | | | | |
| | | | | SUBTOTAL | 5,876 | | 14,152 | 20,028 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. H-4 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6H4

BY : KOTHMANN, K

DATE: 9/18/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant GAS ENGINE DRIVEN R-134a
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| CONSTRUCT CENTRAL PLANT BASE BUILDING | 500 | BSF | | | | 80.00 | 40,000 | 40,000 |
| HISTORICLY COMPATABLE | | | | | | | | |
| CENTRAL PLANT ELECTRICAL SYSTEM | 500 | BSF | | | | 34.00 | 17,000 | 17,000 |
| CHILLER (YORK YG) WITH PIPING & VESELS | 1,000 | TON | 4.5 | 28.91 | 130,095 | 896.00 | 896,000 | 1,026,095 |
| PRIMARY PUMPS 40 HP | 2 | EA | 33.0 | 28.91 | 1,908 | 6,500.00 | 13,000 | 14,908 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 1,000 | TON | 0.6 | 28.91 | 17,346 | 92.00 | 92,000 | 109,346 |
| CENTRAL PLANT CONTROLS | 1 | JOB | 300.0 | 28.91 | 8,673 | 6,000.00 | 6,000 | 14,673 |
| | | | | SUBTOTAL | 158,022 | | 1,064,000 | 1,222,022 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

512 MAIN STREET, SUITE 1500

FORT WORTH, TEXAS 76102-3922

(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. H-4** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6H4 | **DATE:** 9/18/96

**BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** NEW Central Plant GAS ENGINE DRIVEN R-134a
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 5" | 150 | LF | .82 | 28.91 | 3,556 | 24.25 | 3,638 | 7,193 |
| 4" | 100 | LF | .64 | 28.91 | 1,850 | 15.05 | 1,505 | 3,355 |
| 3" | 450 | LF | .57 | 28.91 | 7,415 | 10.39 | 4,676 | 12,091 |
| SUB TOTAL FROM SHEET 1 | | | | | 79,124 | | 57,480 | 136,604 |
| SUB TOTAL FROM SHEET 2 | | | | | 5,876 | | 14,152 | 20,028 |
| SUB TOTAL FROM SHEET 3 | | | | | 158,022 | | 1,064,000 | 1,222,022 |
| | | | | SUBTOTAL | 255,844 | | 1,145,450 | 1,401,294 |
| | | | | O & P @ 20% | 51,169 | | 229,090 | 280,259 |
| | | | | SUBTOTAL | 307,013 | | 1,374,540 | 1,681,553 |
| | | | | DESIGN @ 6% | | | | 100,893 |
| | | | | SUBTOTAL | | | | 1,782,446 |
| | | | | SIOH @ 5.5% | | | | 98,035 |
| | | | | TOTAL | | | | $1,880,480 |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis                                    Study: FSH-2.LC
Energy Conservation Investment Program (ECIP)                LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS          Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-H1
Analysis Date: 09/18/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $436,458 |
| B. SIOH | 25445 |
| C. Design Cost | 26187 |
| D. Total Cost (1A+1B+1C) | $488,090 |
| E. Salvage Value of Existing Equip. | 8000 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $480,090 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 1,016 | Mbtus | $6,380 | 15.08 | $96,218 |
| Elec. Deman | | | | | $3,865 | 14.88 | $57,511 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 1,016 | Mbtus | $10,245 | | $153,729 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $27,480 | Annual | 14.88 | $408,902 |
| ANNUAL TOTAL | $27,480 | | | $408,902 |
| REFRIGERANT RECL | $3,200 | 0 | 1.0 | $3,200 |
| ONE TIME TOTAL | $3,200 | | | $3,200 |
| TOTAL | $30,680 | | | $412,102 |

| | |
|---|---|
| 4. First Year Dollar Savings | $37,885 |
| 5. Simple Payback Period (Years) | 12.67 |
| 6. Total Net Discounted Savings | $565,831 |
| 7. Savings to Investment Ratio<br>If < 1, Project does not qualify | 1.18 |
| 8. Adjusted Internal Rate of Return | 3.85% |

Life Cycle Cost Analysis
Energy Conservation Investment Program (ECIP)
Study: FSH-2.LC
LCCID FY96

Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-H2
Analysis Date: 09/18/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $446,845 |
| B. SIOH | $26,051 |
| C. Design Cost | $26,811 |
| D. Total Cost (1A+1B+1C) | $499,707 |
| E. Salvage Value of Existing Equip. | 8000 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $491,707 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 1,118 | Mbtus | $7,021 | 15.08 | $105,877 |
| Elec. Deman | | | | | $2,229 | 14.88 | $33,168 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 1,118 | Mbtus | $9,250 | | $139,045 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $27,480 | Annual | 14.88 | $408,902 |
| ANNUAL TOTAL | $27,480 | | | $408,902 |
| REFRIGERANT RECL | $3,200 | 0 | 1.0 | $3,200 |
| ONE TIME TOTAL | $3,200 | | | $3,200 |
| TOTAL | $30,680 | | | $412,102 |

| | |
|---|---|
| 4. First Year Dollar Savings | $36,890 |
| 5. Simple Payback Period (Years) | 13.33 |
| 6. Total Net Discounted Savings | $551,147 |
| 7. Savings to Investment Ratio | 1.12 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 3.59% |

Life Cycle Cost Analysis
Study: FSH-2.LC
Energy Conservation Investment Program (ECIP)
LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-H3
Analysis Date: 09/18/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $449,148 |
| B. SIOH | $26,185 |
| C. Design Cost | $26,949 |
| D. Total Cost (1A+1B+1C) | $502,282 |
| E. Salvage Value of Existing Equip. | 8000 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $494,282 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 1,012 | Mbtus | $6,355 | 15.08 | $95,839 |
| Elec. Deman | | | | | $2,517 | 14.88 | $37,453 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 1,012 | Mbtus | $8,872 | | $133,292 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $27,480 | Annual | 14.88 | $408,902 |
| ANNUAL TOTAL | $27,480 | | | $408,902 |
| REFRIGERANT RECL | $3,200 | 0 | 1.0 | $3,200 |
| ONE TIME TOTAL | $3,200 | | | $3,200 |
| TOTAL | $30,680 | | | $412,102 |

| | |
|---|---|
| 4. First Year Dollar Savings | $36,512 |
| 5. Simple Payback Period (Years) | 13.54 |
| 6. Total Net Discounted Savings | $545,394 |
| 7. Savings to Investment Ratio | 1.1 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 3.51% |

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-H4
Analysis Date: 09/18/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | $1,681,553 |
| B. | SIOH | 98035 |
| C. | Design Cost | 100893 |
| D. | Total Cost (1A+1B+1C) | $1,880,481 |
| E. | Salvage Value of Existing Equip. | 8000 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $1,872,481 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 8,940 | Mbtus | $56,143 | 15.08 | $846,640 |
| Elec. Deman | | | | | $47,597 | 14.88 | $708,243 |
| Natural Gas | $3.5 | /Mbtus | -18,260 | Mbtus | -$63,180 | 18.58 | -$1,173,877 |
| TOTAL | | | -9,320 | Mbtus | $40,561 | | $381,006 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $27,480 | Annual | 14.88 | $408,902 |
| ANNUAL TOTAL | $27,480 | | | $408,902 |
| REFRIGERANT RECL | $3,200 | 0 | 1.0 | $3,200 |
| CHILLER RETROFIT | $50,000 | 0 | 1.0 | $50,000 |
| ONE TIME TOTAL | $53,200 | | | $53,200 |
| TOTAL | $80,680 | | | $462,102 |

| | | |
|---|---|---|
| 4. | First Year Dollar Savings | $70,701 |
| 5. | Simple Payback Period (Years) | 26.48 |
| 6. | Total Net Discounted Savings | $843,108 |
| 7. | Savings to Investment Ratio<br>If < 1, Project does not qualify | .45 |
| 8. | Adjusted Internal Rate of Return | -1.03% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | I |
| DATE: | 3/1/96 |
| ECO TITLE: | Retrofit Existing Individual HW Boilers With Central HW Boilers |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 1000, Buildings 1000, 1001, 1029, 1088 |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | -28 | MMBTU/yr |
| Electrical Demand Savings | -158 | $/yr |
| Gas Energy Savings | 80 | MMBTU/yr |
| Total Energy Savings | 52 | MMBTU/yr |
| Total Cost Savings | 10,323 | $/yr |
| Total Investment | 186,539 | $ |
| Simple Payback | 18.07 | yrs |
| SIR | 0.83 | |

A. ECO Description:

Remove the existing boilers in Buildings 1001 and 1029 as indicated in Table-1. The three HW flex-tube boilers in the boiler plant behind Building 1000 are to remain. Provide necessary controls and gas train accessories to retrofit these three Bryan FlexTube HW boilers from two-stage firing to full modulation firing. From the above-ground 8" HW supply and return mains that extend out from the boiler plant, provide 3" take-offs and extend over to Building 1001 through a direct buried HW supply and return loop. Similarly, Provide a second set of 3" HW supply and return take-offs that extend over to Building 1029 through direct buried pipe. Approximately 800 ft of 3" piping for the over head and 1600 ft. of 3" under ground piping will be required for these loops. Replace the steam coils in the four air handlers serving building 1001 with new HW coils of similar heating capacity and two way control valves. Reutilize existing steam piping in Building 1001. A new 180 GPM, 40 ft. head, 5 HP secondary pump will be installed to serve these new HW coils. All other AHU, HW coil three way control valves will be converted to two way valves to minimize pumping energy. The existing HW system for Building 1029 will be connected to this primary HW loop and the existing building HW pump will be reutilized as a secondary pump. Other specific requirements should be determined by the design engineer responsible for the project. This project will require engineering drawings and specifications, demolition and removal of the existing equipment, and installation of the new boiler and its associated wiring and controls.

B. Discussion:

Building 1000 has three 5,500 MBH gas fired boilers which have a two position firing rate (high/low). One of these boilers appears more than capable of handling the HW load of the hospital, while the third boiler is a stand-by boiler. Building 1001 has three natural draft gas fired, low pressure steam boilers. Two of the boilers have been abandoned in place. Moreover, the high temperature of a steam boiler, steam traps, condensate return pumps, and boiler

blowdown in this building increase the maintenance cost and inefficiency of the heating system. Building 1029 has a single natural draft gas fired HW boiler installed in 1990. It is in good condition, but there is no primary bypass on the loop. With both steam and HW systems, it is difficult for the maintenance staff to maintain.

Because the HW boilers serving Building 1002 were installed in 1992, they are in good condition. Moreover, these boilers have the capacity to handle the load of all three buildings. Therefore, it is recommended that these boilers be used to serve the heating loads for all three buildings. In addition, to take advantage of the varying loads imposed on the boilers, the boiler controls should be converted from a two position firing rate to a full modulation firing rate. The manufacturer should be consulted in verifying type of burner and accessories. As noted above, Building 1001 has four AHUs with steam heating coils. With the elimination of the steam boilers, replacement of the steam coils will be necessary. These steam coils will be replaced with new HW coils of similar heating capacity and two way control valves. A new 180 GPM, 5 HP secondary pump will be installed in the basement to serve these new HW coils. Computer simulations of the buildings in this area determined that the current installed capacity of 12,690 MBH serving Building 1000 is more than required to adequately heat all three buildings[1]. Therefore, it is recommended that these boilers be retrofitted to serve all three buildings. All other buildings AHU, HW coil three way control valves will be converted to two way valves to minimize pumping energy and provide better distribution of the HW flow through AHU coils.

C. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed boilers and pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3], and the three boilers were modeled with full modulation firing. An equipment list of the specific boiler and pumps modeled for the proposed central boiler plant is shown on page C-164.

Once the computer simulations of the existing and proposed boiler plants were completed, the total annual energy consumption of the proposed central plant was compared with that of the existing individual systems to determine the annual savings for this ECO[4]. This savings calculations is shown on page C-165. These energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of steam and HW boilers in this area down to the three existing boilers. The total maintenance cost savings from this ECO as calculated on page C-170 is estimated to be $10,380 per year. This figure was used in the life cycle cost analysis..

D. Cost Estimates:

The total installation costs for the retrofitting the boiler plant were estimated on pages C-166 through C-169. These costs were used in the life cycle cost analysis.

E. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-171. The data from the summary sheet were presented in the ECO summary on page C-161.

## REFERENCES

1. Refer to Appendix H for system thermal load profile.
2. Refer to Appendix H for computer model input assumptions, data, and energy consumption data.
3. Refer to Appendix G for building data and existing HVAC equipment data.
4. Refer to Appendix A for utility cost analysis and avoided cost calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-I, FORT SAM HOUSTON, AREA 1000
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| HW Boiler # 1 | 1 | Bryan, # K550WGT, high/low fire rate<br>5000/2500 MBH, 120 HP, flex tube<br>20 f, delta t, 4230 MBH out | served bldg. 1000<br>proposed area 1000 blr<br>retrofit to full modulation | 1992 | 5,500 MBH |
| HW Pump | 1 | TACO # 1030 4x5x12, 25 HP<br>400 GPM, head unknown (90ft. approx.) | Boiler # 1 | 1992 | 18.64 KW |
| HW Boiler # 2 | 1 | Bryan, # K550WGT, high/low fire rate<br>5000/2500 MBH, 120 HP, flex tube<br>20 f, delta t, 4230 MBH out | served bldg. 1000<br>proposed area 1000 blr<br>retrofit to full modulation | 1992 | 5,500 MBH |
| HW Pump | 1 | TACO # 1030 4x5x12, 25 HP<br>400 GPM, head unknown (90ft. approx.) | Boiler # 2 | 1992 | 18.64 KW |
| HW Boiler # 3 | 1 | Bryan, # K550WGT, high/low fire rate<br>5000/2500 MBH, 120 HP, flex tube<br>20 f, delta t, 4230 MBH out | served bldg. 1000<br>proposed area 1000 blr<br>retrofit to full modulation | 1992 | 5,500 MBH |
| HW Pump | 1 | TACO # 1030 4x5x12, 25 HP<br>400 GPM, head unknown (90ft. approx.) | Boiler # 3 | 1992 | 18.64 KW |
| HW Pump | 1 | Bell and Gossett<br>180 GPM, 40 ft.<br>5 HP | Secondary pump for<br>bldg. 1001 | New | 3.73 KW |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

## 1000 AREA

| ITEM | ECO I - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bldg. 1000 Boiler | | | | | | | | | | | | | | 10,809 |
| Bldg. 1000 HW Pump | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 162,936 | |
| Blodg. 1000 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1,095 | |
| Bldg. 1000 Boiler | | | | | | | | | | | | | | 0 |
| Bldg. 1000 HW Pump | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | |
| Bldg. 1000 HW Controls | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | |
| Bldg. 1001 LPS Boiler | | | | | | | | | | | | | | 123 |
| Bldg. 1001 LPS Boiler Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 288 | |
| Bldg. 1029 Boiler | | | | | | | | | | | | | | 130 |
| Bldg. 1029 HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 200 | |
| | | | | | | | | | | | | | | |
| Totals | 18.9 | 18.9 | 18.9 | 18.9 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.9 | 18.9 | 164,519 | 11,062 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 142 | 142 | 142 | 142 | 140 | 187 | 187 | 187 | 187 | 140 | 142 | 142 | | |

Total Demand 1,879 $/yr

Total Energy 562 MMBTU/yr (electric)

Total Energy 11,062 MMBTU/yr (gas)

| ITEM | ECO-I: RETROFIT EXISTING BOILER PLANT MONTHLY PEAK DEMAND (KW) Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HW Boiler # 1 | | | | | | | | | | | | | | 10,982 |
| HW Pump | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 162,936 | |
| HW Controls | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1,095 | |
| HW Pump | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 8,706 | |
| HW Boiler # 2 | | | | | | | | | | | | | | |
| HW Pump | | | | | | | | | | | | | | |
| HW Controls | | | | | | | | | | | | | | |
| HW Boiler # 3 | | | | | | | | | | | | | | |
| HW Pump | | | | | | | | | | | | | | |
| HW Controls | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| Total (KW) | 22.4 | 22.4 | 22.4 | 22.4 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 22.4 | 22.4 | 172,737 | 10,982 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 168 | 168 | 168 | 168 | 140 | 187 | 187 | 187 | 187 | 140 | 168 | 168 | | |

Total Demand 2,037 $/yr

Demand Savings -158 $/yr

Energy Savings -28 MMBTU/yr (electric)

Energy Savings 80 MMBTU/yr (gas)

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX
ECO NO. I Retrofit Existing Individual Boilers AREA 1000

PROJECT NO: 03-185.61 | DATE: 9/19/96
BY : KOTHMANN, K | CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| REMOVE BOILER | 4 | EA | 90.0 | 28.91 | 10,408 | 780.00 | 3,120 | 13,528 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 3" | 1,600 | LF | 0.6 | 28.91 | 27,754 | 15.70 | 25,120 | 52,874 |
| SCH 40 BKL STL PIPE W/ FTGS HNGRS & INSULATION | | | | | | | | |
| 3" | 800 | LF | 1.1 | 28.91 | 25,441 | 11.55 | 9,240 | 34,681 |
| SUBTOTAL | | | | | 63,602 | | 37,480 | 101,082 |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| TOTAL | | | | | | | | |


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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. I Retrofit Existing Individual Boilers AREA 1000

PROJECT NO: 03-185.61

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX 3" | 2 | EA | 7.0 | 28.91 | 405 | 475.00 | 950 | 1,355 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 150.0 | 20.00 | 3,000 | 2,000.00 | 2,000 | 5,000 |
| SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING HW PUMPS PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 10.7 | 28.91 | 309 | 717.00 | 717 | 1,026 |
| REPLACE STEAM COILS AND VALVES | 4 | SET | 16.0 | 28.91 | 1,850 | 1,900.00 | 7,600 | 9,450 |
| REPLACE 3-WAY CONTROL VALVES WITH 2-WAY | 1 | JOB | 240.0 | 28.91 | 6,938 | 9,000.00 | 9,000 | 15,938 |
| | | | | SUBTOTAL | 12,503 | | 20,267 | 32,770 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FT SAM HOUSTON , SAN ANTONIO TEX | **PROJECT NO:** 03-185.61 | **DATE:** 9/19/96

**ECO NO. I** Retrofit Existing Boilers AREA 1000 | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| MODIFY EXISTING BOILER FOR FULL FIRING | 3 | EA | 12.00 | 28.91 | 1,041 | 600.00 | 1,800 | 2,841 |
| Test , Balance & Start-up | 1 | LS | 80.00 | 28.91 | 2,313 | | | 2,313 |
| | | | | SUBTOTAL | 3,354 | | 1,800 | 5,154 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. 1 Retrofit Existing Boilers AREA 1000

PROJECT NO: 03-185.61

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
245156 Bldg SF Condition Space AREA 1000

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 63,602 | | 37,480 | 101,082 |
| SUB TOTAL FROM SHEET 2 | | | | | 12,503 | | 20,267 | 32,770 |
| SUB TOTAL FROM SHEET 3 | | | | | 3,354 | | 1,800 | 5,154 |
| SUBTOTAL | | | | | 79,458 | | 59,547 | 139,005 |
| O & P @ 20% | | | | | 15,892 | | 11,909 | 27,801 |
| SUBTOTAL | | | | | 95,350 | | 71,456 | 166,806 |
| DESIGN @ 6% | | | | | | | | 10,008 |
| SUBTOTAL | | | | | | | | 176,815 |
| SIOH @ 5.5% | | | | | | | | 9,725 |
| TOTAL | | | | | | | | $186,540 |

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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. I Retrofit Existing BOILERS

PROJECT NO: 03-0185.6MA

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment
AREA 1000

ANNUAL COSTS

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER BOILER PER YEAR | | | | | | | | |
| EXISTING BOILER | -4. | EA | 100.0 | 30.00 | -12,000 | 1,800.00 | -7,200 | -19,200 |
| **NEW EQUIPMENT** | | | | | | | | |
| AERCO MODULAR HIGH EFFICIENCY HW BOILER | 2. | EA | 80.0 | 30.00 | 4,800 | 1,500.00 | 4,020 | 8,820 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -7,200 | | -3,180 | -10,380 |


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Life Cycle Cost Analysis
Study: FSH-2.LC
Energy Conservation Investment Program (ECIP)
LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-I
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $166,806 |
| B. SIOH | $9,725 |
| C. Design Cost | $10,008 |
| D. Total Cost (1A+1B+1C) | $186,539 |
| E. Salvage Value of Existing Equip. | 0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $186,539 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | -28 | Mbtus | -$176 | 15.08 | -$2,652 |
| Elec. Deman | | | | | -$158 | 14.88 | -$2,351 |
| Natural Gas | $3.5 | /Mbtus | 80 | Mbtus | $277 | 18.58 | $5,143 |
| TOTAL | | | 52 | Mbtus | -$57 | | $140 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRIN | $10,380 | Annual | 14.88 | $154,454 |
| ANNUAL TOTAL | $10,380 | | | $154,454 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $10,380 | | | $154,454 |

| | |
|---|---|
| 4. First Year Dollar Savings | $10,323 |
| 5. Simple Payback Period (Years) | 18.07 |
| 6. Total Net Discounted Savings | $154,595 |
| 7. Savings to Investment Ratio | .83 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 2.04% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | J |
| DATE: | 3/1/96 |
| ECO TITLE: | Install Energy Management System (EMS) For HVAC System |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 1300, Buildings 1350, 1374, 1375, 1377, 1379, 1380, 1382, 1384, 1385, 1387, 1396, and 1398 |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 3105 | MMBTU/yr |
| Electrical Demand Savings | -471 | $/yr |
| Gas Energy Savings | 915 | MMBTU/yr |
| Total Energy Savings | 4020 | MMBTU/yr |
| Total Cost Savings | 22,194 | $/yr |
| Total Investment | 970,739 | $ |
| Simple Payback | 43.7 | yrs |
| SIR | 0.36 | |

B. ECO Description:

Install Energy Management System (EMS) at the central maintenance facility. The EMS will accomplish the following tasks for all of the equipment listed in Table-1 in all of the above mentioned buildings.

1. All AHU's serving buildings in the table below will be furnished with all necessary controls to facilitate an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode, which will save thermal cooling energy. (several damaged OA dampers require repairs). Buildings 1387, 1396 and 1398 are not included in this option.

2. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature. Building 1384 is the only building that will not have this option. All other buildings are included.

3. All multi-zone units and all single zone units with or without reheat coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures after the reheat coil will be monitored. The cooling coil

leaving air temperature will be reset to satisfy at least one zone thermostat without reheat. Buildings 1377, 1387, 1396 and 1398 are not included in this option.

4. All multi-zone units will have air side temperature reset. AHU heating supply air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full heat (at least one zone damper will be fully open). Buildings 1377, 1387, 1396 and 1398 are not included in this option.

5. A night / day setback program will be provided to control window units and fan coil units, and split systems. The program will set back the temperature of the controlled space to a predetermined set-point during periods of no occupancy. Several space or unit mounted temperature sensors will be installed to control the units that currently are controlled under manual operation or no control.

6. Chillers serving Buildings 1377 and 1384 chillers will have chilled water temperature reset. The leaving CHW temperature will be reset to maintain varying load conditions.

7. Buildings 1377 and 1384 chillers will have condenser water temperature reset. The CW leaving temperature will be maintained as low as OA conditions permit in the summer season.

Table-1

| Building # | Equipment To Be Controlled |
|---|---|
| 1350 | 7 AHUs and 20 FCUs1374,1375, 1379,1380 |
| 1374,75,79,80 | 6 AHUs each bldg. |
| 1382 | 2 AHUs |
| 1384 | 5 AHUs, Chiller, CHW pump, Boiler and HW pump. |
| 1385 | 1 AHU |
| 1377 | 2 AHUs. (All area 1300 chillers and boilers are located in this building.) |
| 1374,75,79,80 | 3 Chillers, 2 Cooling Towers and 3 HW Boilers. |
| 1387 | 7 Heat Pumps and 7 AHUs |
| 1396 | 3 Air cooled CND, 2 DX coil units, HW Boiler and 3 HW pumps |
| 1398 | 1 Air cooled Cnd, HW Boiler and 1 HW /CHW pump and 20 FCUs |

C. Discussion:

1. Generally, the ambient condition in San Antonio area is warm and humid. Annual free cooling hours will be limited. A large number of AHUs are equipped with necessary dampers to support an economizer cycle. This indicates that the original HVAC system was designed to have an economizer cycle. All OA and RA dampers will be repaired and retrofitted with necessary controls to support an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode. When the enthalpy of the OA will drops below that of RA, then the OA damper will open, and the RA damper will close. This action will reduce the cooling energy required. The benefit of this system will occur in both the heating and cooling season. In the heating season when the ambient temperature falls below the temperature needed to maintain the supply air at design conditions, the OA damper will remain in the preset minimum open position to permit necessary ventilation.

2. Regardless of occupancy hours, all AHU's are operated 24 hours per day, 365 days per year to maintain space temperature. However, the chillers operate only during the cooling season do as boilers in the heating season. Depending on occupancy schedules, ambient conditions and building thermal characteristics, most AHU's and their associated chillers, boilers , CHW and HW pumps will be turned off daily in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHU's will remain off during weekends and holidays.

Several temperature sensors will be installed in the spaces served by these AHU's. These sensors will monitor the space temperature during unoccupied hours. During the cooling season when the space temperature exceeds 85 F, the AHU's and their associated cooling auxiliaries serving that space will energize to cool the space below 85 F. When the space temperature reaches 84 F, they will cycle off. Similarly, the winter time unoccupied period space temperature will be maintained at 65 F.

The EMS system will have the capability to manually override this operation with a change in schedule. All AHU's serving the critical areas such as the computer room unit will operate as usual and will not be connected to the new start/stop program. However, if desired, their current operation and performance can be monitored by the new EMS system.

3. Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's. (Boilers and chillers have a seasonal operation, hot and cold air mixing never occurs return air mixes with cold air in the summer and with hot air in winter.) In both cases, cooling and heating energy is wasted. Our observations indicate that all zones are mixing cold supply and return air to maintain the room or zone temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur. The same control sequence will be applied to the hot deck temperature control.

In multi-zone units, cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air temperature will be increased to minimize mixing. This process will continue until one of the zones doesn't require mixing. (A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.). Buildings 1377, 1387, 1396 and 1398 are not included in this option as they do not have a multi-zone system.

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Our observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. Heating supply air temperature will be lowered until at least one zone damper remains fully open to satisfy the room or area heating demand. Many of the partially open heating dampers indicate a higher than necessary heating deck temperature. Therefore, lowering the temperature will save heating energy. Buildings

1377, 1387, 1396 and 1398 are not included in this option as they do not have a multi-zone system.

5. During periods when the facility remains unoccupied, the window units, fan coil units and split systems that serve non-critical areas will be reset to an "unoccupied" space temperature condition. Temperature sensors will monitor the space temperature at all times, and when the program determines the unoccupied periods, the temperature set point will rise from 78°F to 85°F for summer cooling conditions and from 70°F to 65°F for winter cooling conditions. When the space temperature exceeds 85°F during unoccupied periods, then it will energize the unit and its associated auxiliary cooling equipment. Similarly, when the space temperature falls below 65°F during unoccupied periods, then it will energize the unit and its associated auxiliary heating equipment.

   The EMS will have the capability to override this operation with a change in schedule or function. Also, this will not apply to window units, fan coil units, and split systems serving critical areas such as computer rooms. These units will operate as usual, and they will connected to the new start stop program unless their operation and performance needs to be monitored.

6. Retrofit the chillers at Buildings 1377 and 1384 with chilled water temperature reset controls. Upon a decrease in ambient temperature, the leaving CHW temperature will increase. An increase in leaving CHW temperature decreases the KW/ton which will reduce the electrical energy required.

7. Chillers at Buildings 1377 and 1384 will be furnished with condenser water temperature reset controls. As the differential pressure between the evaporator and condenser decreases, the energy required to operate the chiller compressor decreases. Therefore, a reduction in condenser water temperature will save energy. However, the cooling tower fan energy will increase to produce a lower condenser water temperature. Therefore, multi-step thermostats monitoring devices and controls will be installed to operate the condenser water reset option. The EMS system will monitor and activate the reset program when atmospheric conditions permit, and when the energy savings from the chiller's compressor exceed the additional cooling tower fan energy required to produce a lower condenser water temperature.

   The EMS system will be controlled by a personal computer (PC) located in the central maintenance building. All other building control panels will be connected to the central EMS system PC in the Building via telephone lines.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed EMS system were calculated using the Trace 600 computer program[1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations of the existing and new EMS system were completed, the total annual demand cost and energy consumption were compared with that of the existing and new

systems to determine the annual savings for this ECO[3]. These savings calculations are shown on pages C-179 through C-182. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings with this retrofit.

E. Cost Estimates:

The total installation costs for the new EMS system are estimated on pages C-183 through C-185. These costs were obtained using an estimated IO point list as shown on pages C-177 through C-178. These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-186. The data from the summary sheet were presented in the ECO summary on page C-172.

REFERENCES


1. Refer to Appendix H for system thermal load profile.
2. Refer to Appendix G building field data and existing HVAC equipment data.
3. Refer to Appendix A for utility cost analysis and avoided cost calculations.

AREA:
1300

ECO J: INSTALL EMS FOR HVAC EQUIPMENT

OCCUPANCY TIME:
VARIES

| | HARDWARE | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | | | |
| GRAPHIC DISPLAY ● / POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE | DIFFERENITAL PRESSURE | POSITION |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| W/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 3 | | | | | | | | | | | | | | | | 3 | | | | |
| CHW PUMP | 3 | | | | | | | | | | | | | | 3 | | | | | | | | | | |
| CW PUMP | 3 | | | | | | | | | | | | | | 3 | | | | | | | | | | |
| TWR. FAN | 3 | | | | | | | | | | | | | | 3 | | | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 3 | | | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 3 | | | | | | | |
| CW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 3 | | | | | | | |
| CW RETURN HEADER | | | | | | | | | | | | | | | | | | 3 | | | | | | | |
| TWR. BYPASS VALVE | | | | | | | | 3 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| W/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 1 | | | | | | | | | | | | | | | | 1 | | | | |
| CHW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| TWR. FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| CW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| CW RETURN HEADER | | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| TWR. BYPASS VALVE | | | | | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| CONDENSERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| CND. FAN | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| CW SUPPLY HEADER | | | | | | | | | | | | | | | | | | | | | | | | | |
| CW RETURN HEADER | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| HW BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 5 | | | | | | | 5 | | | | | | | | | | | | | |
| HW PUMP | 5 | | | | | | | | | | | | | | 5 | | | | | | | | | | |
| HW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 5 | | | | | | | |
| HW RETURN HEADER | | | | | | | | | | | | | | | | | | 5 | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| HW BOILER ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 1 | | | | | | | 1 | | | | | | | | | | | | | |
| HW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| HW SUPPLY HEADER | | | | | | | | | | | | | | | | | | | | | | | | | |
| HW RETURN HEADER | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| AHU (FACE AND BYPASS-SZ) ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 2 | | | | | | | | | | | | 2 | | | | | | | |
| HOT DECK TEMP. | | | | | | 2 | | | | | | | | | | | | 2 | | | | | | | |
| BYPASS DAMPER | | | | | | | 2 | | | | | | | | | | | | | | | | | | |
| RETURN AIR | | | | | | | 2 | | | | | | | | | | | 2 | | | | | | | |
| OUTSIDE AIR | | | | | | | 2 | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 2 | | | | | | | |

| | | | | | | SOFTWARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANALOG | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | | | |
| WATTS | GAGE PRESSURE | DIFFERENITAL PRESSURE | POSITION | FLOW | $O_2$ AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / [illegible] | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER [illegible] | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | X | X | | X | | | X | X | X | | | | tl |
| | | | | | | X | | | | | | | | | | | | | | | | | | | X | | | | | | X | | | | | | |
| | | | | | | X | | | | | | | | | | | | | | | | | | | X | | | | | | X | | | | | | |
| | | | | | | X | | | | | | | | | | | | | | | | | | | X | | X | | | | X | | | | | | |
| | | | | 3 | | | | | X | X | | | | | | | | | | | | | | | | X | | | | | | | | | | | |
| | | | | | | | | | X | X | | | | | | | | | | | | | | | | X | | | | | | | | | | | |
| | | | | | | | | | X | X | | | | | | | | | | | | | | | | | X | | | | | | | | | | |
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| | | | | | | | | | X | X | | | | | | | | | | | | | | | | | X | | | | | | | | | | |
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| | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | |
| | | | | 5 | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | |

| LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |
| | | X | X | X | | | | | three (3) chillers serving bldgs. 1350, 1374 |
| | | X | | | | | | | 1375, 1379, 1380, 1385, 1382, & 1377 |
| | | X | | | | | | | |
| | | X | | | | | | | |
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| | | | | | | | | | |
| | | | | | | | | | one (1) chiller serving bldg. 1384 |
| | | X | X | X | | | | | |
| | | X | | | | | | | |
| | | X | | | | | | | |
| | | X | | | | | | | |
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| | | | | | | | | | bldg. 1396 & 1398 condensers |
| | | X | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | four (4) boilers serving bldgs. 1350, 1374 |
| | X | | | | | | | | 1375, 1379, 1380, 1385, 1382, & 1377 |
| | | X | | | | | | | and one (1) boiler serving bldg. 1384 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | two (2) boilers serving bldgs. 1396 & 1398 |
| | X | | | | | | | | |
| | | X | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | two (2) AHUs serving bldg. 1377 |
| | | X | | | | | | | |
| | | | | | | | | | all valves, dampers, thermostats, and |
| | | | | | | | | | actuators are existing. |
| | | | | | | | | | |
| | | | | | | | | | |
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| | | | | | | | | | |

ECO J: INSTALL EMS FOR HVAC EQUIPMENT

OCCUPANCY TIME: VARIES

| AREA: 1300 | HARDWARE | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANAL | | | | |
| GRAPHIC DISPLAY ● / POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS |
| AHU (MZ) ● | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 32 | | | | | | | | | | | | | | 32 | | | | | | | |
| COLD DECK TEMP. | | | | | | 32 | | | | | | | | | | | | 32 | | | | |
| HOT DECK TEMP. | | | | | | 32 | | | | | | | | | | | | 32 | | | | |
| RETURN AIR | | | | | | | 32 | | | | | | | | | | | 32 | | | | |
| OUTSIDE AIR | | | | | | | 32 | | | | | | | | | | | | | | | |
| ZONE DAMPERS | | | | | | | 136 | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 136 | | | | |
| FILTER | | | | | | | | | | 32 | | | | | | | | | | | | |
| AHU (VAV) ● | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 7 | | | | | | | | | | | | | | 7 | | | | | | | |
| RETURN FAN | 7 | | | | | | | | | | | | | | 7 | | | | | | | |
| COLD DECK TEMP. | | | | | | 7 | | | | | | | | | | | | 7 | | | | |
| HOT DECK TEMP. | | | | | | 7 | | | | | | | | | | | | 7 | | | | |
| RETURN AIR | | | | | | | 7 | | | | | | | | | | | 7 | | | | |
| OUTSIDE AIR | | | | | | | 7 | | | | | | | | | | | | | | | |
| ZONE DAMPERS | | | | | | | 35 | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 35 | | | | |
| FILTER | | | | | | | | | | 7 | | | | | | | | | | | | |
| FAN COIL UNIT ● | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 57 | | | | |
| PACKAGED AHU ● | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 1 | | | | |
| OUTSIDE AIR ● | | | | | | | | | | | | | | | | | | 1 | 1 | | | |

TOTAL AO POINTS = 78

TOTAL DO POINTS = 341

TOTAL AI POINTS = 115

TOTAL DI POINTS = 395

GRAND TOTAL POINTS = 929

NOTES:

1. BUILDING 1387 WAS NOT INCLUDED IN THE EMS BECAUSE THE BUILDING IS SERVED BY ALL ELECTRIC HEAT PUI

T

| ANALOG | | | | | | | | | SOFTWARE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | |
| RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE | DIFFERENITAL PRESSURE | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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'RIC HEAT PUMPS WHICH ARE CAPABLE OF OPERATING UNDER LOCAL CONTROLS AND DO NOT NEED MONITORING.

| LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | ahus serving bldgs. 1374, 1375, 1379, 1380, |
| | | X | | | | | | 1382, 1384, & 1385 |
| | | | | | | | | |
| | | | | | | | | all valves, dampers, thermostats, and |
| | | | | | | | | actuators are existing. |
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| | | | | | | | | |
| | | | | | | | | bldg. 1350 ahus |
| | | X | | | | | | |
| | | X | | | | | | all valves, dampers, thermostats, and |
| | | | | | | | | actuators are existing. |

1300 AREA

| ITEM | EXISTING BUILDING SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1350 Chiller | | | | | 315.0 | 311.6 | 326.8 | 330.2 | 321.9 | 230.6 | | | 548,265 | |
| Bldg. 1350 Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 60,178 | |
| Bldg. 1350 CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| Bldg. 1350 CW Pump | | | | | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | | | 98,918 | |
| Bldg. 1350 CHWControls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1377 Plant Chiller (CHLR-1) | | | | | 481.2 | 496.7 | 503.9 | 510.2 | 495.7 | 411.0 | | | 1,212,362 | |
| CHLR-1 Cooling Tower Fans | | | | | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | | | 210,623 | |
| CHLR-1 CHW pump | | | | | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | | | 82,579 | |
| CHLR-1 CW pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CHW (CHLR-1) Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| CHLR-1 CHW pump # 2 | | | | | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | | | 82,579 | |
| Bldg. 1377 Plant Chiller (CHLR-2) | | | | | 273.4 | 344.6 | 499.0 | 510.2 | 378.4 | | | | 99,925 | |
| CHLR-2 CW pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 24,558 | |
| CHW (CHLR-2) Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 823 | |
| Bldg. 1384 Chiller | | | | | 204.0 | 195.4 | 206.9 | 215.1 | 194.1 | 140.9 | | | 376,812 | |
| Bldg. 1384 Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 59,652 | |
| Bldg. 1384 CHW pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 1384 CW pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,798 | |
| Bldg. 1384 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1387 Heat Pumps - cooling | 84.5 | 87.3 | 84.4 | 84.4 | 96.4 | 106.6 | 118.7 | 123.0 | 103.2 | 70.1 | 84.4 | 84.4 | 333,506 | |
| Heat Pumps Fans - cooling | | | | | 7.1 | 7.7 | 11.8 | 11.8 | 7.7 | 5.0 | | | 11,209 | |
| Heat Pumps Controls - cooling | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 434 | |
| Bldg. 1396 split system - cooling | | | | | 8.4 | 9.6 | 10.2 | 10.1 | 9.4 | 7.5 | | | 8,987 | |
| Bldg. 1396 condenser fans | | | | | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 0.7 | | | 966 | |
| Bldg. 1396 split system controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 979 | |
| Bldg. 1396 packaged unit - cooling | | | | | 54.3 | 60.8 | 64.3 | 63.8 | 59.4 | 32.5 | | | 42,379 | |
| Bldg. 1396 condenser fans | | | | | 3.3 | 3.6 | 3.7 | 3.7 | 3.6 | 2.0 | | | 2,733 | |
| Bldg. 1396 CHW controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 556 | |
| Bldg. 1398 recip chiller- cooling | | | | | 61.2 | 66.1 | 69.9 | 70.7 | 68.9 | 37.4 | | | 62,597 | |
| Bldg. 1398 condenser fans | | | | | 5.4 | 5.6 | 5.6 | 5.6 | 5.6 | 3.4 | | | 5,481 | |
| Bldg. 1398 CHW pump | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| Bldg. 1396 CHW controls | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 442 | |
| Bldg. 1350 fans | 134.2 | 134.2 | 134.2 | 134.2 | 134.2 | 128.2 | 130.3 | 131.5 | 134.0 | 133.4 | 134.2 | 134.2 | 648,613 | |
| Bldg. 1374 fans | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 294,336 | |
| Bldg. 1375 fans | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 294,336 | |
| Bldg. 1379 fans | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 294,336 | |
| Bldg. 1380 fans | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 294,336 | |
| Bldg. 1385 fans | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 19,272 | |
| Bldg. 1382 fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 65,700 | |
| Bldg. 1377 fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 65,700 | |
| Bldg. 1384 fans | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 620,208 | |
| Bldg. 1384 fans | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Bldg. 1387 fans | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 159,561 | |
| Bldg. 1396 fans | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 81,468 | |
| Bldg. 1398 fans | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 16,644 | |
| Bldg. 1398 fans | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 3,504 | |

1300 AREA

| ITEM | EXISTING BUILDING SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1350 HW blr (BLR-1) | | | | | | | | | | | | | | 20.5 |
| Bldg. 1350 HW pump (BLR-1) | 29.8 | 29.8 | | | | | | | | | | | 1,192 | |
| Bldg. 1350 BLR-1 controls | 0.1 | 0.1 | | | | | | | | | | | 5 | |
| Bldg. 1350 HW blr (BLR-2) | | | | | | | | | | | | | | |
| Bldg. 1350 HW pump (BLR-2) | | | | | | | | | | | | | | |
| Bldg. 1350 BLR-2 controls | | | | | | | | | | | | | | |
| Bldg. 1377 Plant HW blr (BLR-1) | | | | | | | | | | | | | | 5,371.3 |
| HW pump (BLR-1) | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48,653 | |
| BLR-1 controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW pump (BLR-1) | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48,653 | |
| HW blr f.d. fan (BLR-1) | 7.5 | 7.5 | 7.5 | 7.5 | | | | | | | 7.5 | 7.5 | 32,580 | |
| Bldg. 1377 Plant HW blr (BLR-2) | | | | | | | | | | | | | | |
| HW pump (BLR-2) | | | | | | | | | | | | | | |
| HW blr f.d. fan (BLR-2) | | | | | | | | | | | | | | |
| BLR-2 controls | | | | | | | | | | | | | | |
| Bldg. 1384 HW boiler | | | | | | | | | | | | | | 208.5 |
| Bldg. 1384 HW pump | 5.6 | 5.6 | 5.6 | 5.6 | | | | | | | 5.6 | 5.6 | 8,394 | |
| Bldg. 1384 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 187 | |
| Bldg. 1387 Electric Heat | 87.8 | 87.3 | 54.8 | 4.5 | | | | | | | 49.6 | 85.4 | 69,232 | |
| Bldg. 1396 HW boiler | | | | | | | | | | | | | | 636.5 |
| Bldg. 1396 HW pump | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 869 | |
| Bldg. 1396 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 1396 HW pump | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 869 | |
| Bldg. 1398 HW boiler | | | | | | | | | | | | | | 445.2 |
| Bldg. 1398 HW pump | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 16,073 | |
| Bldg. 1398 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| | | | | | | | | | | | | | | |
| Totals | 632.4 | 634.7 | 569.4 | 519.1 | 2,166.5 | 2,259.2 | 2,473.8 | 2,508.6 | 2,304.6 | 1,565.4 | 564.2 | 600.0 | 6,854,343 | 6,682.0 |
| Rate ($/KW) | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 10.0 | 10.0 | 10.0 | 10.0 | 7.5 | 7.5 | 7.5 | | |
| Cost ($) | 4,743.0 | 4,760.3 | 4,270.5 | 3,893.3 | 16,248.8 | 22,592.0 | 24,738.0 | 25,086.0 | 23,046.0 | 11,740.5 | 4,231.5 | 4,500.0 | | |

| | | |
|---|---|---|
| Total Demand | 149,849.8 $/yr | |
| Total Energy | 23,393.9 MMBTU/yr | (electric) |
| Total Energy | 6,682.0 MMBTU/yr | (gas) |

| ITEM | ECO J - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1350 Chiller | | | | | 312 | 322 | 327 | 330 | 322 | 291 | | | 527,062 | |
| Bldg. 1350 Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,887 | |
| Bldg. 1350 CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| Bldg. 1350 CND Pump | | | | | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | | | 98,918 | |
| Bldg. 1350 CHWControls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1377 Plant Chiller (CHLR-1 | | | | | 481.2 | 496.7 | 503.9 | 510.2 | 495.7 | 425.7 | | | 1,211,446 | |
| CHLR-1 Cooling Tower Fans | | | | | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | | | 230,604 | |
| CHLR-1 CHW pump | | | | | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | | | 82,579 | |
| CHLR-1 CND pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CHW (CHLR-1) Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1377 CHLR-1 CHW pump | | | | | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | | | 82,579 | |
| Bldg. 1377 Plant Chiller (CHLR-2 | | | | | 281.5 | 391.4 | 503.9 | 510.2 | 394.1 | | | | 211,152 | |
| | | | | | | | | | | | | | | |
| Bldg. 1377 CHLR-2 CND pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 34,435 | |
| CHW (CHLR-2) Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 1,154 | |
| Bldg. 1384 Chiller | | | | | 201.4 | 192.3 | 204.1 | 212.6 | 190.8 | 135.2 | | | 338,034 | |
| Bldg. 1384 Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,798 | |
| Bldg. 1384 CHW pump | | | | | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | 11.2 | | | 49,459 | |
| Bldg. 1384 CND pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,798 | |
| Bldg. 1384 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1387 Heat Pumps - cooling | 93.8 | 92.6 | 84.4 | 84.4 | 100.9 | 107.7 | 119.7 | 123.6 | 104.0 | 70.1 | 84.4 | 88.7 | 329,687 | |
| Heat Pumps Fans - cooling | | | | | 8.3 | 8.3 | 11.8 | 11.8 | 8.3 | 5.0 | | | 11,196 | |
| Heat Pumps Controls - cooling | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 434 | |
| Bldg. 1396 split system - cooling | | | | | 8.9 | 9.8 | 10.1 | 10.0 | 9.4 | 5.2 | | | 7,088 | |
| Bldg. 1396 condenser fans | | | | | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 0.6 | | | 782 | |
| Bldg. 1396 split system controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 839 | |
| Bldg. 1396 packaged unit - coolin | | | | | 56.9 | 61.7 | 64.0 | 63.5 | 59.4 | 34.5 | | | 42,172 | |
| Bldg. 1396 condenser fans | | | | | 3.5 | 3.7 | 3.7 | 3.7 | 3.6 | 2.2 | | | 2,554 | |
| Bldg. 1396 CHW controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 341 | |
| Bldg. 1398 recip chiller- cooling | | | | | 67.0 | 68.0 | 69.9 | 70.7 | 68.9 | 41.0 | | | 73,971 | |
| Bldg. 1398 condenser fans | | | | | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 3.8 | | | 6,757 | |
| Bldg. 1398 CHW pump | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| Bldg. 1396 CHW controls | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 442 | |
| Bldg. 1350 fans | 130.0 | 121.8 | 134.2 | 134.2 | 124.6 | 129.2 | 131.0 | 132.5 | 134.2 | 134.2 | 134.2 | 134.2 | 389,017 | |
| Bldg. 1374 fans | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 168,298 | |
| Bldg. 1375 fans | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 168,298 | |
| Bldg. 1379 fans | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 168,343 | |
| Bldg. 1380 fans | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 33.6 | 168,342 | |
| Bldg. 1385 fans | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 6,954 | |
| Bldg. 1382 fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 38,693 | |
| Bldg. 1377 fans | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 39,420 | |
| Bldg. 1384 fans | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 70.8 | 620,208 | |
| Bldg. 1384 fans | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Bldg. 1387 fans | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 18.2 | 95,736 | |
| Bldg. 1396 fans | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 22,636 | |
| Bldg. 1398 fans | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 5,542 | |

| ITEM | ECO J - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1398 fans | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 1,264 | |
| Bldg. 1350 HW blr (BLR-1) | | | | | | | | | | | | | | 65.3 |
| Bldg. 1350 HW pump (BLR-1) | 29.8 | 29.8 | | | | | | | | | | | 2,682 | |
| Bldg. 1350 BLR-1 controls | 0.1 | 0.1 | | | | | | | | | | | 11 | |
| Bldg. 1350 HW blr (BLR-2) | | | | | | | | | | | | | | |
| Bldg. 1350 HW pump (BLR-2) | | | | | | | | | | | | | | |
| Bldg. 1350 BLR-2 controls | | | | | | | | | | | | | | |
| Bldg. 1377 Plant HW blr (BLR-1) | | | | | | | | | | | | | | 5,149.7 |
| HW pump (BLR-1) | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48,653 | |
| BLR-1 controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW pump (BLR-1) | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48,653 | |
| HW blr f.d. fan (BLR-1) | 7.5 | 7.5 | 7.5 | 7.5 | | | | | | | 7.5 | 7.5 | 32,580 | |
| Bldg. 1377 Plant HW blr (BLR-2) | | | | | | | | | | | | | | |
| HW pump (BLR-2) | | | | | | | | | | | | | | |
| HW blr f.d. fan (BLR-2) | | | | | | | | | | | | | | |
| BLR-2 controls | | | | | | | | | | | | | | |
| Bldg. 1384 HW boiler | | | | | | | | | | | | | | 248.5 |
| Bldg. 1384 HW pump | 5.6 | 5.6 | 5.6 | 5.6 | | | | | | | 5.6 | 5.6 | 10,198 | |
| Bldg. 1384 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 228 | |
| Bldg. 1387 Electric Heat | 69.0 | 82.7 | 4.5 | 4.5 | | | | | | | 4.5 | 81.2 | 22,957 | |
| Bldg. 1396 HW boiler | | | | | | | | | | | | | | 152.8 |
| Bldg. 1396 HW pump | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 869 | |
| Bldg. 1396 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 1396 HW pump | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 869 | |
| Bldg. 1398 HW boiler | | | | | | | | | | | | | | 151.2 |
| Bldg. 1398 HW pump | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 16,073 | |
| Bldg. 1398 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| | | | | | | | | | | | | | | |
| Totals | 618.7 | 623.0 | 519.1 | 519.1 | 2,174.0 | 2,319.3 | 2,477.2 | 2,507.3 | 2,319.1 | 1,639.1 | 519.1 | 600.1 | 5,944,514 | 5,767.5 |
| Rate ($/KW) | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 10.0 | 10.0 | 10.0 | 10.0 | 7.5 | 7.5 | 7.5 | | |
| Cost ($) | 4,640.3 | 4,672.5 | 3,893.3 | 3,893.3 | 16,305.0 | 23,193.0 | 24,772.0 | 25,073.0 | 23,191.0 | 12,293.3 | 3,893.3 | 4,500.8 | | |

| | | |
|---|---|---|
| Total Demand | 150,320.5 $/yr | |
| Demand Savings | -470.8 $/yr | |
| Energy Savings | 3,105.2 MMBTU/yr | (electric) |
| Energy Savings | 914.5 MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO,TX | **PROJECT NO:** 03-0185.06J | **DATE:** 9/19/96

**ECO NO. J** AREA 1300 | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | HRS/ UNIT | Rate | Total | Unit Price | Total | |
| EMCS COSTS BASED ON DDC ALL ELECTRIC | | | | | | | | |
| DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE | | | | | | | | |
| DIGITAL OUTPUT DEVICE : | | | | | | | | |
| START-STOP MOTOR | 68 | EA | 10.2 | 28.91 | 20,052 | 175.74 | 11,950 | 32,002 |
| ENABLE/DISABLE APPARATUS RELAY | 10 | EA | 4.5 | 28.91 | 1,301 | 49.00 | 490 | 1,791 |
| ANALOG OUTPUT: | | | | | | | | |
| CONTROL VALVE (COIL/AHU ACTUATOR ONLY) | 86 | EA | 11.9 | 28.91 | 29,636 | 571.00 | 49,106 | 78,742 |
| DAMPER ACTUATOR & MOTOR | 255 | EA | 11.9 | 28.91 | 87,875 | 340.00 | 86,700 | 174,575 |
| DIGITAL INPUT: | | | | | | | | |
| DIFFERENTIAL PREASURE SWITCH | 41 | EA | 10.1 | 28.91 | 11,972 | 227.30 | 9,319 | 21,291 |
| AUXILIARY CONTACT | 6 | EA | 4.5 | 28.91 | 781 | 49.00 | 294 | 1,075 |
| CURRENT SENSING RELAY | 68 | EA | 4.5 | 28.91 | 8,846 | 49.00 | 3,332 | 12,178 |
| SHEET 1 | | | | | | | | |
| | | | | SUBTOTAL | 160,463 | | 161,192 | 321,654 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX | PROJECT NO: 03-0185.06J | DATE: 9/19/96 |
| ECO NO. J AREA 1300 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | UNIT MEAS | Hrs / Unit | Rate | Total | Unit Price | Total | |
| ANALOG INPUT: | | | | | | | | |
| TEMP. SENSER & THERMO WELL | 26 | EA | 17.0 | 28.91 | 12,778 | 426.42 | 11,087 | 23,865 |
| TEMP. SENSER AIR DUCT | 123 | EA | 12.0 | 28.91 | 42,671 | 450.00 | 55,350 | 98,021 |
| TEMP. SENSER OUTSIDE AIR | 1 | EA | 12.0 | 28.91 | 347 | 550.00 | 550 | 897 |
| TEMP. SENSER ZONE | 231 | EA | 12.0 | 28.91 | 80,139 | 556.00 | 128,436 | 208,575 |
| RELATIVE HUMIDITY % | 1 | EA | 13.0 | 28.91 | 376 | 615.00 | 615 | 991 |
| AMPERES | 4 | EA | 7.0 | 28.91 | 809 | 219.00 | 876 | 1,685 |
| GAUGE PRESURE BOILER | | | | | | | | |
| FLOW STATUS / RATE | 9 | EA | 17.0 | 28.91 | 4,423 | 410.00 | 3,690 | 8,113 |
| EQUIPMENT FAILURE ALARM | 20 | EA | 2.6 | 28.91 | 1,503 | 108.00 | 2,160 | 3,663 |
| FILTER ALARM | 41 | EA | 4.5 | 28.91 | 5,334 | 227.00 | 9,307 | 14,641 |
| HIGH & LOW LIMIT (HYDRONIC) | 21 | PR | 2.0 | 28.91 | 1,214 | 170.00 | 3,570 | 4,784 |
| SHEET 2 | | | | | | | | |
| | | | | SUBTOTAL | 149,595 | | 215,641 | 365,236 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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FORT WORTH, TEXAS 76102-3922
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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX | PROJECT NO: 03-0185.06J | DATE: 9/19/96 |
| ECO NO. J AREA 1300 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| OPERATORS' WORKSTATION | 1 | SUM | | | | 13,184.00 | 13,184 | 13,184 |
| INCLUDING MODEM & REMOTE PANEL | | | | | | | | |
| SUBMITTALS, TRAINING & START-UP | 1 | JOB | | | | 8,300.00 | 8,300 | 8,300 |
| SOFTWARE | 1 | LS | | | | 15,000.00 | 15,000 | 15,000 |
| SUB TOTAL FROM SHEET 1 | | | | | 160,463 | | 161,192 | 321,654 |
| SUB TOTAL FROM SHEET 2 | | | | | 149,595 | | 215,641 | 365,236 |
| | | | | SUBTOTAL | 310,057 | | 413,317 | 723,374 |
| | | | | O & P @ 20% | 62,011 | | 82,663 | 144,675 |
| | | | | SUBTOTAL | 372,069 | | 495,980 | 868,049 |
| | | | | DESIGN @ 6% | | | | 52,083 |
| | | | | SUBTOTAL | | | | 920,132 |
| | | | | SIOH @ 5.5% | | | | 50,607 |
| | | | | TOTAL | | | | $970,739 |

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Life Cycle Cost Analysis — Study: FSH-2.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-J
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | $868,049 |
| B. | SIOH | $50,607 |
| C. | Design Cost | $52,083 |
| D. | Total Cost (1A+1B+1C) | $970,739 |
| E. | Salvage Value of Existing Equip. | 0 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $970,739 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 3,105 | Mbtus | $19,501 | 15.08 | $294,070 |
| Elec. Deman | | | | | -$471 | 14.88 | -$7,008 |
| Natural Gas | $3.5 | /Mbtus | 915 | Mbtus | $3,164 | 18.58 | $58,790 |
| TOTAL | | | 4,020 | Mbtus | $22,194 | | $345,852 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $22,194 |
| 5. Simple Payback Period (Years) | 43.74 |
| 6. Total Net Discounted Savings | $345,852 |
| 7. Savings to Investment Ratio<br>If < 1, Project does not qualify | .36 |
| 8. Adjusted Internal Rate of Return | -2.18% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | K |
| DATE: | 3/1/96 |
| ECO TITLE: | Replace Existing Central Chillers With New Electric Centrifugal Chiller |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 1300, Building 1377 (serves buildings 1350, 1374, 1375, 1377, 1379, 1380, 1382, 1385, 1385, 1396, and 1398) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 4393 | MMBTU/yr |
| Electrical Demand Savings | 43,719 | $/yr |
| Gas Energy Savings | 0 | MMBTU/yr |
| Total Energy Savings | 4393 | MMBTU/yr |
| Total Cost Savings | 95,249 | $/yr |
| Total Investment | 1,441,745 | $ |
| Simple Payback | 13.0 | yrs |
| SIR | 1.17 | |

B. ECO Description:

Remove the two 600 ton, R-11 centrifugal chillers in Building 1377 which were installed in 1972, and replace them with two R-123 centrifugal chillers, rated at 570 tons each. The two existing chilled water pumps and condenser water pumps serving the existing chillers should be removed. Remove the 273 ton, R-11 centrifugal chiller serving Building 1384, and associated controls and CW water equipment. Remove the condenser and reciprocating chiller serving Building 1398 and the condenser serving building 1396. Replace the 50 ton packaged unit serving Building 1396 with an AHU with CHW coil and a two-way control valve. CHW pump in Building 1398 shall remain and be used as a secondary pump. Install new 40 HP CHW and CW pump to serve the new chillers and a new 3 HP CH pump to provide secondary water in Building 1386. The new chillers should be connected into the distribution piping at locations of the existing to be removed chillers. New chilled water supply and return headers should be installed to join together the existing distribution systems serving Building 1350 and the other buildings in the 1300 area. This will create a single chilled water distribution system to be served by the new chillers and the existing 438 ton chiller which was installed in 1983 to serve building 1350. A new 6" direct buried primary CHW supply and return piping loop will be constructed and connected with the three primary pumps. This loop will require a 2.5" take-off that is capped that will serve Building 1387 in the future. The loop will have approximately 200 ft. of 6", 900 ft. of 4", 800 ft. of 2.5", 1800 ft. of 3" and 400 ft of 2.0" piping to complete this primary loop. All existing controls and electrical services should be reconnected where possible. Specific requirements in these areas should be determined by the design engineer responsible for this project. To meet the current ASHRAE Standard 15, a refrigerant detection and ventilation system should be installed. This project will require engineering drawings and specifications, demolition and removal of the existing chillers and pumps, and installation of the new chillers, pumps, associated wiring and controls.

C. Discussion:

There are currently two primary independent chilled water distribution systems serving the 1300 area, one for Building 1350 and the other for Buildings 1374, 1375, 1377, 1379, 1380, 1382, and

1385. These two systems should be combined into one system to conserve energy in the central plant. This can be accomplished by installing common CHW supply and return headers in the central plant. In addition, Buildings 1384, 1396, and 1398 have individual cooling equipment that serves each building separately. The existing centrifugal chiller serving Building 1350 was installed in 1983, is rated at 438 tons and appears to be in good condition. The two existing centrifugal chillers serving the other seven buildings were installed in 1972, are rated at 600 tons each, and appear to be near the end of their useful life. The centrifugal chiller serving Building 1384 was installed in 1973 and also appears to be reaching the end of it's expected life. Buildings 1396 and 1398 are served by DX packaged systems and water cooled reciprocating chillers respectively. Building 1387 is served by all electric heat pumps that were instaled in 1988. These units appear to be in good shape, and thus it does not appear advantageous to retrofit this building with water cooled equipment at this time.

The three chillers located in the central plant adjacent to Building 1377 and the chiller serving building 1384 have R-11 refrigerant, which is no longer be manufactured as of January 1, 1996[1]. To avoid the anticipated increasing operational costs over the life of these machines, they should either be retrofitted to use an approved refrigerant or replaced with new machines that operate on one. The existing centrifugal machines can be retrofitted to an approved refrigerant by modifying the impeller, gears, etc... However, a retrofit to the older chillers will cause an approximate degradation in tonnage of 5%-7% and a 3%-5% efficiency loss because the technology is not available to match these impellers yet. With the case of the Carrier chiller serving Building 1350, this can be done with no loss in capacity of efficiency with the onset of new technology of redesigning the impellers for existing chillers. One company which produces these new impellers for existing R-11 centrifugal machines has provided cost estimates[2]. Therefore, since the older machines are already over twenty years old and retrofitting them would create a greater loss in efficiency, it is recommended that the facility replace them instead. A life cycle cost analysis performed on four different types of replacement chillers available determined that a single electric centrifugal chiller using R-134 would be the most economical choice over the life of the machine. Computer simulations of the buildings served by this machine determined that the current installed capacity of 1,790 tons is more than what is required to adequately cool the buildings[3]. Therefore, the new combined capacity is recommended to be 1,575 tons to more nearly match the building cooling load.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumptions of the existing and proposed alternative chillers and auxiliary equipment were calculated using the Trace 600 computer program[4]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[5].

The two 570 ton chiller alternatives which were compared included an electric centrifugal machine, an electric centrifugal with a variable frequency drive, a dual screw machine and a gas driven centrifugal machine. All proposed machines used R-134 or R-123. Full load performance data from York International were used in the computer simulations of the new chiller energy usages. Equipment lists of the specific chillers and auxiliaries for each alternative modeled by the computer are shown on pages C-191 to C-194

Once the computer simulations were completed, the total annual demand cost and energy consumption of each alternative were compared with that of the existing systems to determine the annual savings for each[6]. These savings calculations are shown on pages C-195 through C-197. The demand and energy savings values were used in the life cycle cost analysis for each alternative. The results of these savings calculations were as follows:

| Alternative | Chiller Type | Demand Savings $/yr | Electrical Savings MMBTU/yr | Gas Savings MMBTU/yr |
|---|---|---|---|---|
| **K1** | Electric Centrifugal | 43,719 | 4393 | 0 |
| **K2** | Electric Centrifugal & VFD | 42,465 | 4721 | 0 |
| **K3** | Electric Screw | 28,829 | 3169 | 0 |
| **K4** | Gas Driven Centrifugal | 74,012 | 9083 | -15,872 |

2. *Maintenance Cost Savings*:

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water cooled chillers in this area down to three water cooled chillers. The total maintenance cost savings from this ECO is estimated to be $20,243 per year as shown on page C-210. This figure was used in the life cycle cost analysis.

E. Cost Estimates

The total installation costs for each alternative chiller mentioned in this ECO were estimated on pages C-198 through C-209. These costs were used in the life cycle cost analysis for each alternative. The results of the costs estimates were as follows:

| Alternative | Chiller Type | Estimated Cost |
|---|---|---|
| **K1** | Electric Centrifugal | $1,237,515 |
| **K2** | Electric Centrifugal & VFD | $1,295,598 |
| **K3** | Electric Screw | $1,609,265 |
| **K4** | Gas Driven Centrifugal | $2,098,173 |

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on each chiller alternative for this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. By installing two new centrifugal chillers alongside an existing centrifugalchiller in the place of the existing equipment, the installation will save the cost of retrofitting the twoother R-11 machines for the HCFC-123 refrigerant as mentioned previously. The cost of this retrofit was estimated to be

$35,000 per chiller and shown as a non-recurring cost associated with this ECO. Moreover, there is a second non-recurring cost associated with the reclaim value of the refrigerant R-11. This cost was estimated at $2.00 per pound of R-11 and 2 pounds per ton for a total cost of $3,944. A summary sheet for each life cycle cost analysis is shown on pages C-211 through C-214. The results of the alternative life cycle cost analysis were as follows:

| Alternative | Chiller Type | Payback Years | SIR |
|---|---|---|---|
| **K1** | Electric Centrifugal | 13.0 | 1.17 |
| **K2** | Electric Centrifugal & VFD | 13.5 | 1.12 |
| **K3** | Electric Screw | 22.2 | 0.69 |
| **K4** | Gas Driven Centrifugal | 21.0 | 0.63 |

Since the electric centrifugal chillers have the highest SIR, they are recommended as the most economical choice to replace the existing machines. The data from the life cycle cost analysis for this alternative were included in the summary on page C-187.

## REFERENCES


1. Per current EPA regulations on CFC refrigerants.
2. See Appendix F for chiller retrofit information from Northeastern Research And Engineering Corporation.
3. See Appendix H for Area 1300 cooling system load profile.
4. See Appendix H for computer model input assumptions and data, and energy consumption output data.
5. See Appendix G for building field data and existing HVAC system data.
6. See Appendix A for utility cost analysis data, used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-K1, FORT SAM HOUSTON, AREA 1300

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 2 | York YT<br>water cooled, centrifugal,<br>570 tons, R-123 | Area 1300 | New | 313 KW |
| Chilled Water Pump | 2 | Bell & Gossett<br>1140 gpm, 115 ft<br>40 HP | Area 1300 | New | 29.80 KW |
| Condenser Water Pump | 2 | Bell & Gossett<br>1710 gpm, 70 ft<br>40 HP | Area 1300 | New | 29.80 KW |
| Cooling Tower | 1 | Marley #324T<br>induced draft,<br>2-35 HP fans | served two existing chlrs in series, now serves new chillers | 1972 | 52.22 KW |
| Water Chiller | 1 | Carrier #19DK 78942P<br>water cooled, centrifugal,<br>438 tons, R-123 | Retrofitted to R-123 served bldg. 1350, now serves all of 1300 | 1983 | 334.5 KW |
| Chilled Water Pump | 1 | Allis Chalmers<br>775 gpm, 114 ft<br>40 HP | served bldg. 1350, now serves all of 1300 | 1983 | 29.84 KW |
| Condenser Water Pump | 1 | Allis Chalmers<br>1314 gpm, 30 ft<br>30 HP | served bldg. 1350, now serves all of 1300 | 1983 | 22.38 KW |
| Cooling Tower | 1 | Marley<br>induced draft,<br>20 HP fan | served bldg. 1350, now serves all of 1300 | 1983 | 14.92 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>96 GPm, 30' hd<br>3 HP | secondary pump for building 1396 | New | 2.20 KW |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-K2, FORT SAM HOUSTON, AREA 1300
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 2 | York YT with VFD<br>water cooled, centrifugal,<br>570 tons, R-123 | Area 1300 | New | 313 KW |
| Chilled Water Pump | 2 | Bell & Gossett<br>1140 gpm, 115 ft<br>40 HP | Area 1300 | New | 29.80 KW |
| Condenser Water Pump | 2 | Bell & Gossett<br>1710 gpm, 70 ft<br>40 HP | Area 1300 | New | 29.80 KW |
| Cooling Tower | 1 | Marley #324T<br>induced draft,<br>2-35 HP fans | served two existing chlrs in series, now serves new chillers | 1972 | 52.22 KW |
| Water Chiller | 1 | Carrier #19DK 78942P<br>water cooled, centrifugal,<br>438 tons, R-123 | Retrofitted to R-123<br>served bldg. 1350, now serves all of 1300 | 1983 | 334.5 KW |
| Chilled Water Pump | 1 | Allis Chalmers<br>775 gpm, 114 ft<br>40 HP | served bldg. 1350, now serves all of 1300 | 1983 | 29.84 KW |
| Condenser Water Pump | 1 | Allis Chalmers<br>1314 gpm, 30 ft<br>30 HP | served bldg. 1350, now serves all of 1300 | 1983 | 22.38 KW |
| Cooling Tower | 1 | Marley<br>induced draft,<br>20 HP fan | served bldg. 1350, now serves all of 1300 | 1983 | 14.92 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>96 GPm, 30' hd<br>3 HP | secondary pump for building 1396 | New | 2.20 KW |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-K3, FORT SAM HOUSTON, AREA 1300
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 2 | York YS<br>water cooled screw<br>570 tons, R-123 | Area 1300 | New | 365 KW |
| Chilled Water Pump | 2 | Bell & Gossett<br>1140 gpm, 115 ft<br>40 HP | Area 1300 | New | 29.80 KW |
| Condenser Water Pump | 2 | Bell & Gossett<br>1710 gpm, 70 ft<br>40 HP | Area 1300 | New | 29.80 KW |
| Cooling Tower | 1 | Marley #324T<br>induced draft,<br>2-35 HP fans | served two existing chlrs in series, now serves new chillers | 1972 | 52.22 KW |
| Water Chiller | 1 | Carrier #19DK 78942P<br>water cooled, centrifugal,<br>438 tons, R-123 | Retrofitted to R-123 served bldg. 1350, now serves all of 1300 | 1983 | 334.5 KW |
| Chilled Water Pump | 1 | Allis Chalmers<br>775 gpm, 114 ft<br>40 HP | served bldg. 1350, now serves all of 1300 | 1983 | 29.84 KW |
| Condenser Water Pump | 1 | Allis Chalmers<br>1314 gpm, 30 ft<br>30 HP | served bldg. 1350, now serves all of 1300 | 1983 | 22.38 KW |
| Cooling Tower | 1 | Marley<br>induced draft,<br>20 HP fan | served bldg. 1350, now serves all of 1300 | 1983 | 14.92 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>96 GPm, 30' hd<br>3 HP | secondary pump for building 1396 | New | 2.20 KW |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-K4, FORT SAM HOUSTON, AREA 1300
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 2 | York, gas engine driven YG<br>water cooled, centrifugal<br>570 tons, R-134a | Area 1300 | New | 3,762 MBH |
| Chilled Water Pump | 2 | Bell & Gossett<br>1140 gpm, 115 ft<br>40 HP | Area 1300 | New | 29.80 KW |
| Condenser Water Pump | 2 | Bell & Gossett<br>1710 gpm, 70 ft<br>40 HP | Area 1300 | New | 29.80 KW |
| Cooling Tower | 1 | Marley #324T<br>induced draft,<br>2-35 HP fans | served two existing chlrs in series, now serves new chillers | 1972 | 52.22 KW |
| Water Chiller | 1 | Carrier #19DK 78942P<br>water cooled, centrifugal,<br>438 tons, R-123 | Retrofitted to R-123 served bldg. 1350, now serves all of 1300 | 1983 | 334.5 KW |
| Chilled Water Pump | 1 | Allis Chalmers<br>775 gpm, 114 ft<br>40 HP | served bldg. 1350, now serves all of 1300 | 1983 | 29.84 KW |
| Condenser Water Pump | 1 | Allis Chalmers<br>1314 gpm, 30 ft<br>30 HP | served bldg. 1350, now serves all of 1300 | 1983 | 22.38 KW |
| Cooling Tower | 1 | Marley<br>induced draft,<br>20 HP fan | served bldg. 1350, now serves all of 1300 | 1983 | 14.92 KW |
| Chilled Water Pump | 1 | Bell & Gossett<br>96 GPm, 30' hd<br>3 HP | secondary pump for building 1396 | New | 2.20 KW |
| | | | | | |
| | | | | | |

1300 AREA

| ITEM | ECO K - EXISTING BUILDING SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1350 Chiller | | | | | 315.0 | 311.6 | 326.8 | 330.2 | 321.9 | 230.6 | | | 548,265 | |
| Bldg. 1350 Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 60,178 | |
| Bldg. 1350 CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| Bldg. 1350 CND Pump | | | | | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | | | 98,918 | |
| Bldg. 1350 CHWControls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1377 Plant Chiller (CH-1) | | | | | 481.2 | 496.7 | 503.9 | 510.2 | 495.7 | 411.0 | | | 1,212,362 | |
| CHLR-1 Cooling Tower Fans | | | | | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | | | 210,623 | |
| CHLR-1 CHW pump | | | | | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | | | 82,579 | |
| CHLR-1 CND pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CHW (CHLR-1) Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| CHLR-1 CHW pump # 2 | | | | | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | | | 82,579 | |
| Bldg. 1377 Plant Chiller (CH-2) | | | | | 273.4 | 344.6 | 499.0 | 510.2 | 378.4 | | | | 99,925 | |
| CHLR-2 CND pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 24,558 | |
| CHW (CHLR-2) Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 823 | |
| Bldg. 1384 Chiller | | | | | 204.0 | 195.4 | 206.9 | 215.1 | 194.1 | 140.9 | | | 376,812 | |
| Bldg. 1384 Cooling Tower | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 59,652 | |
| Bldg. 1384 CND pump | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | 65,798 | |
| Bldg. 1384 CHW Controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 1396 split system - clg | | | | | 8.4 | 9.6 | 10.2 | 10.1 | 9.4 | 7.5 | | | 8,987 | |
| Bldg. 1396 condenser fans | | | | | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 0.7 | | | 966 | |
| Bldg. 1396 split system controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 979 | |
| Bldg. 1396 packaged unit - clg | | | | | 54.3 | 60.8 | 64.3 | 63.8 | 59.4 | 32.5 | | | 42,379 | |
| Bldg. 1396 condenser fans | | | | | 3.3 | 3.6 | 3.7 | 3.7 | 3.6 | 2.0 | | | 2,733 | |
| Bldg. 1396 CHW controls | | | | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | | | 556 | |
| Bldg. 1398 recip chiller- clg | | | | | 61.2 | 66.1 | 69.9 | 70.7 | 68.9 | 37.4 | | | 62,597 | |
| Bldg. 1398 condenser fans | | | | | 5.4 | 5.6 | 5.6 | 5.6 | 5.6 | 3.4 | | | 5,481 | |
| Bldg. 1396 CHW controls | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 442 | |
| | | | | | | | | | | | | | | |
| Totals | | | | | 1,657.9 | 1,745.8 | 1,942.1 | 1,971.4 | 1,788.8 | 1,086.0 | | | 3,324,634 | |
| Rate ($/KW) | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 10.0 | 10.0 | 10.0 | 10.0 | 7.5 | 7.5 | 7.5 | | |
| Cost ($) | | | | | 12,434.3 | 17,458.0 | 19,421.0 | 19,714.0 | 17,888.0 | 8,145.0 | | | | |

| | | |
|---|---|---|
| Total Demand | 95,060.3 $/yr | |
| Total Energy | 11,347.0 MMBTU/yr | (electric) |
| Total Energy | MMBTU/yr | (gas) |

| ITEM | ECO-K1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (CH-1) | | | | | 286.9 | 298.2 | 303.4 | 308.0 | 297.0 | 254.7 | | | 989,061 | |
| Cooling Tower Fans | | | | | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | | | 212,341 | |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Water Chiller (CH-2) | | | | | 286.9 | 292.5 | 303.4 | 308.0 | 297.4 | | | | 384,949 | |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 65,620 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 65,620 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 2,202 | |
| Existing Chiller (CH-3) | | | | | | 324.3 | 332.3 | 335.7 | | | | | 27,486 | |
| Cooling Tower Fans | | | | | | 14.9 | 14.9 | 14.9 | | | | | 4,939 | |
| CHW Pump | | | | | | 29.8 | 29.8 | 29.8 | | | | | 9,864 | |
| CND Pump | | | | | | 22.4 | 22.4 | 22.4 | | | | | 7,414 | |
| CHWControls | | | | | | 1.0 | 1.0 | 1.0 | | | | | 331 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 747.2 | 1,156.5 | 1,180.6 | 1,193.2 | 767.8 | 367.5 | | | 2,037,437 | |
| Rate ($/KW) | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 10.0 | 10.0 | 10.0 | 10.0 | 7.5 | 7.5 | 7.5 | | |
| Cost ($) | | | | | 5,604.0 | 11,565.0 | 11,806.0 | 11,932.0 | 7,678.0 | 2,756.3 | | | | |

| | | |
|---|---|---|
| Total Demand | 51,341.3 $/yr | |
| Demand Savings | 43,719.0 $/yr | |
| Energy Savings | 4,393.2 MMBTU/yr | (electric) |
| Energy Savings | MMBTU/yr | (gas) |

| ITEM | ECO-K2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (CH-1) | | | | | 313.0 | 313.0 | 313.0 | 313.0 | 313.0 | 313.0 | | | 1,052,304 | |
| Cooling Tower Fans | | | | | 38.2 | 43.5 | 47.4 | 52.2 | 44.1 | 23.6 | | | 67,085 | |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Water Chiller (CH-2) | | | | | 313.0 | 313.0 | 313.0 | 313.0 | 313.0 | | | | 370,906 | |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 65,620 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 65,620 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 2,202 | |
| Existing Chiller (CH-3) | | | | | | 324.3 | 332.3 | 335.7 | | | | | 27,486 | |
| Cooling Tower Fans | | | | | | 14.9 | 14.9 | 14.9 | | | | | 4,939 | |
| CHW Pump | | | | | | 29.8 | 29.8 | 29.8 | | | | | 9,864 | |
| CND Pump | | | | | | 22.4 | 22.4 | 22.4 | | | | | 7,414 | |
| CHWControls | | | | | | 1.0 | 1.0 | 1.0 | | | | | 331 | |
| Total (KW) | | | | | 785.4 | 1,183.1 | 1,195.0 | 1,203.2 | 791.3 | 397.2 | | | 1,941,381 | |
| Rate ($/KW) | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 10.0 | 10.0 | 10.0 | 10.0 | 7.5 | 7.5 | 7.5 | | |
| Cost ($) | | | | | 5,890.5 | 11,831.0 | 11,950.0 | 12,032.0 | 7,913.0 | 2,979.0 | | | | |

| | | |
|---|---|---|
| Total Demand | 52,595.5 $/yr | |
| Demand Savings | 42,464.8 $/yr | |
| Energy Savings | 4,721.0 MMBTU/yr | (electric) |
| Energy Savings | MMBTU/yr | (gas) |

| ITEM | ECO-K3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (CH-1) | | | | | 337.4 | 349.2 | 354.8 | 359.5 | 348.4 | 304.7 | | | 1,163,188 | |
| Cooling Tower Fans | | | | | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | | | 211,288 | |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Water Chiller (CH-2) | | | | | 337.4 | 348.0 | 354.8 | 359.5 | 348.4 | 304.7 | | | 441,162 | |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 74,530 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 74,530 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 2,501 | |
| Existing Chiller (CH-3) | | | | | 320.2 | 324.3 | 332.3 | 335.7 | 327.8 | | | | 116,280 | |
| Cooling Tower Fans | | | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | | | 9,892 | |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 19,757 | |
| CND Pump | | | | | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | | | | 14,851 | |
| CHWControls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 663 | |
| | | | | | | | | | | | | | | |
| Total (KW) | | | | | 1,236.5 | 1,263.0 | 1,283.4 | 1,296.2 | 1,266.1 | 782.8 | | | 2,396,252 | |
| Rate ($/KW) | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 10.0 | 10.0 | 10.0 | 10.0 | 7.5 | 7.5 | 7.5 | | |
| Cost ($) | | | | | 9,273.8 | 12,630.0 | 12,834.0 | 12,962.0 | 12,661.0 | 5,871.0 | | | | |

| | | | |
|---|---|---|---|
| Total Demand | 66,231.8 | $/yr | |
| Demand Savings | 28,828.5 | $/yr | |
| Energy Savings | 3,168.6 | MMBTU/yr | (electric) |
| Energy Savings | | MMBTU/yr | (gas) |

| ITEM | ECO-K4: NEW GAS ENGINE CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (CH-1) | | | | | | | | | | | | | | 11,618.8 |
| Cooling Tower Fans | | | | | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | 52.2 | | | 212,322 | |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 131,597 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Water Chiller (CH-2) | | | | | | | | | | | | | | 4,253.4 |
| CHW Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 65,620 | |
| CND Pump | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 65,620 | |
| CHW controls | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 2,202 | |
| Existing Chiller (CH-3) | | | | | | 324.3 | 332.3 | 335.7 | | | | | 27,486 | |
| Cooling Tower Fans | | | | | | 14.9 | 14.9 | 14.9 | | | | | 4,939 | |
| CHW Pump | | | | | | 29.8 | 29.8 | 29.8 | | | | | 9,864 | |
| CND Pump | | | | | | 22.4 | 22.4 | 22.4 | | | | | 7,414 | |
| CHWControls | | | | | | 1.0 | 1.0 | 1.0 | | | | | 331 | |
| Total (KW) | | | | | 173.4 | 565.8 | 573.8 | 577.2 | 173.4 | 112.8 | | | 663,408 | 15,872.2 |
| Rate ($/KW) | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 10.0 | 10.0 | 10.0 | 10.0 | 7.5 | 7.5 | 7.5 | | |
| Cost ($) | | | | | 1,300.5 | 5,658.0 | 5,738.0 | 5,772.0 | 1,734.0 | 846.0 | | | | |

| | | | |
|---|---|---|---|
| Total Demand | 21,048.5 | $/yr | |
| Demand Savings | 74,011.8 | $/yr | |
| Energy Savings | 9,082.8 | MMBTU/yr | (electric) |
| Energy Savings | -15,872.2 | MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-0185.6K1 **DATE:** 9/19/96

**ECO NO. K-1** Replace Existing Chillers

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW CHILLERS and HVAC Equipment WATER COOLED CENTRIFUGAL
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 1,483 | TON | 1.1 | 28.91 | 47,161 | 20.00 | 29,660 | 76,821 |
| RMV PUMP | 4 | EA | 6.0 | 28.91 | 694 | 50.00 | 200 | 894 |
| RMV COOLING TOWER | 1 | EA | 150.0 | 28.91 | 4,337 | 1,900.00 | 1,900 | 6,237 |
| RMV PACKAGE UNIT | 50 | TON | 1.5 | 28.91 | 2,168 | 500.00 | 25,000 | 27,168 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 200 | LF | 1.0 | 28.91 | 5,782 | 29.50 | 5,900 | 11,682 |
| 4" | 900 | LF | 0.8 | 28.91 | 19,514 | 19.55 | 17,595 | 37,109 |
| 3" | 1,800 | LF | 0.6 | 28.91 | 31,223 | 15.70 | 28,260 | 59,483 |
| 2-1/2" | 800 | LF | 0.5 | 28.91 | 11,564 | 13.33 | 10,664 | 22,228 |
| 2" | 400 | LF | 0.4 | 28.91 | 4,626 | 13.33 | 5,332 | 9,958 |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| | | | | SUBTOTAL | 129,468 | | 127,011 | 256,479 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. K-1** Replace Existing Chillers

**PROJECT NO:** 03-185.6k1 **DATE:** 9/19/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 1 | LOC | 10.7 | 28.91 | 308 | 717.00 | 717 | 1,025 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 1,140 | TON | 3.2 | 28.91 | 105,464 | 371.00 | 422,940 | 528,404 |
| AHU CH 2-PIPE WITH VALVES & PIPING | 50 | TON | 2.9 | 28.91 | 4,120 | 660.00 | 33,000 | 37,120 |
| PRIMARY PUMPS 40 HP | 2 | EA | 60.0 | 28.91 | 3,469 | 6,900.00 | 13,800 | 17,269 |
| CNDNSR PUMP 40 HP | 2 | EA | 60.0 | 28.91 | 3,469 | 6,900.00 | 13,800 | 17,269 |
| RETROFIT EXISTING CHILLER TO R-123 | 1 | JOB | | | | 35,000.00 | 35,000 | 35,000 |
| CHILLER PLANT MANIFOLD & VALVES | 1 | JOB | 133.0 | 28.91 | 3,845 | 9,600.00 | 9,600 | 13,445 |
| CENTRAL PLANT CONTROLS | 1 | JOB | 300.0 | 28.91 | 8,673 | 6,000.00 | 6,000 | 14,673 |
| | | | | SUBTOTAL | 129,799 | | 535,892 | 665,691 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-185.6k1

DATE: 9/19/96

ECO NO. K-1 Replace Existing Chillers

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| SUB TOTAL FROM SHEET 1 | | | | | 129,468 | | 127,011 | 256,479 |
| SUB TOTAL FROM SHEET 2 | | | | | 129,799 | | 535,892 | 665,691 |
| | | | | SUBTOTAL | 259,267 | | 662,903 | 922,170 |
| | | | | O & P @ 20% | 51,853 | | 132,581 | 184,434 |
| | | | | SUBTOTAL | 311,120 | | 795,484 | 1,106,604 |
| | | | | DESIGN @ 6% | | | | 66,396 |
| | | | | SUBTOTAL | | | | 1,173,000 |
| | | | | SIOH @ 5.5% | | | | 64,515 |
| | | | | TOTAL | | | | $1,237,515 |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.6K2 | DATE: 9/19/96

ECO NO. K-2 Replace Existing Chillers | BY : KOTHMANN, K | CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW CHILLERS and HVAC Equipment WATER COOLED CENTRIFUGAL W/ VFD
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 1 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 1,483 | TON | 1.1 | 28.91 | 47,161 | 20.00 | 29,660 | 76,821 |
| RMV PUMP | 4 | EA | 6.0 | 28.91 | 694 | 50.00 | 200 | 894 |
| RMV COOLING TOWER | 1 | EA | 150.0 | 28.91 | 4,337 | 1,900.00 | 1,900 | 6,237 |
| RMV PACKAGE UNIT | 50 | TON | 1.5 | 28.91 | 2,168 | 500.00 | 25,000 | 27,168 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 200 | LF | 1.0 | 28.91 | 5,782 | 29.50 | 5,900 | 11,682 |
| 4" | 900 | LF | 0.8 | 28.91 | 19,514 | 19.55 | 17,595 | 37,109 |
| 3" | 1,800 | LF | 0.6 | 28.91 | 31,223 | 15.70 | 28,260 | 59,483 |
| 2-1/2" | 800 | LF | 0.5 | 28.91 | 11,564 | 13.33 | 10,664 | 22,228 |
| 2" | 400 | LF | 0.4 | 28.91 | 4,626 | 13.33 | 5,332 | 9,958 |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| | | | | SUBTOTAL | 129,468 | | 127,011 | 256,479 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. K-2 Replace Existing Chillers

PROJECT NO: 03-185.6K2

BY : KOTHMANN, K

DATE: 9/19/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL W/ VFD
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 1 | LOC | 10.7 | 28.91 | 308 | 717.00 | 717 | 1,025 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 1,140 | TON | 3.2 | 28.91 | 105,464 | 371.00 | 422,940 | 528,404 |
| ADD FOR VFD | 250 | HP | 0.8 | 28.91 | 5,782 | 150.00 | 37,500 | 43,282 |
| PRIMARY PUMPS 40 HP | 2 | EA | 60.0 | 28.91 | 3,469 | 6,900.00 | 13,800 | 17,269 |
| CNDNSR PUMP 40 HP | 2 | EA | 60.0 | 28.91 | 3,469 | 6,900.00 | 13,800 | 17,269 |
| AHU CH 2-PIPE WITH VALVES & PIPING | 50 | TON | 2.9 | 28.91 | 4,120 | 660.00 | 33,000 | 37,120 |
| RETROFIT EXISTING CHILLER TO R-123 | 1 | JOB | | | | 35,000.00 | 35,000 | 35,000 |
| CHILLER PLANT MANIFOLD & VALVES | 1 | JOB | 133.0 | 28.91 | 3,845 | 9,600.00 | 9,600 | 13,445 |
| CENTRAL PLANT CONTROLS | 1 | JOB | 300.0 | 28.91 | 8,673 | 6,000.00 | 6,000 | 14,673 |
| | | | | SUBTOTAL | 135,581 | | 573,392 | 708,973 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-185.6K2

DATE: 9/19/96

ECO NO. K-2 Replace Existing Chillers

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL W/ VFD
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 129,468 | | 127,011 | 256,479 |
| SUB TOTAL FROM SHEET 2 | | | | | 135,581 | | 573,392 | 708,973 |
| | | | | SUBTOTAL | 265,049 | | 700,403 | 965,452 |
| | | | O & P @ 20% | | 53,010 | | 140,081 | 193,090 |
| | | | | SUBTOTAL | 318,059 | | 840,484 | 1,158,542 |
| | | | DESIGN @ 6% | | | | | 69,513 |
| | | | | SUBTOTAL | | | | 1,228,055 |
| | | | SIOH @ 5.5% | | | | | 67,543 |
| | | | | TOTAL | | | | $1,295,598 |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.6K3 | DATE: 9/19/96

ECO NO. K-3 Replace Existing Chillers | BY : KOTHMANN, K | CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW CHILLERS and HVAC Equipment WATER COOLED SCREW
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 1,483 | TON | 1.1 | 28.91 | 47,161 | 20.00 | 29,660 | 76,821 |
| RMV PUMP | 4 | EA | 6.0 | 28.91 | 694 | 50.00 | 200 | 894 |
| RMV COOLING TOWER | 1 | EA | 150.0 | 28.91 | 4,337 | 1,900.00 | 1,900 | 6,237 |
| RMV PACKAGE UNIT | 50 | TON | 1.5 | 28.91 | 2,168 | 500.00 | 25,000 | 27,168 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 200 | LF | 1.0 | 28.91 | 5,782 | 29.50 | 5,900 | 11,682 |
| 4" | 900 | LF | 0.8 | 28.91 | 19,514 | 19.55 | 17,595 | 37,109 |
| 3" | 1,800 | LF | 0.6 | 28.91 | 31,223 | 15.70 | 28,260 | 59,483 |
| 2-1/2" | 800 | LF | 0.5 | 28.91 | 11,564 | 13.33 | 10,664 | 22,228 |
| 2" | 400 | LF | 0.4 | 28.91 | 4,626 | 13.33 | 5,332 | 9,958 |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| | | | | SUBTOTAL | 129,468 | | 127,011 | 256,479 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. K-3 Replace Existing Chillers

PROJECT NO: 03-185.6k3

BY : KOTHMANN, K

DATE: 9/19/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 1 | LOC | 10.7 | 28.91 | 308 | 717.00 | 717 | 1,025 |
| CHILLER (YORK YS) WITH PIPING & VESELS | 1,140 | TON | 3.2 | 28.91 | 105,464 | 614.00 | 699,960 | 805,424 |
| AHU CH 2-PIPE WITH VALVES & PIPING | 50 | TON | 2.9 | 28.91 | 4,120 | 660.00 | 33,000 | 37,120 |
| PRIMARY PUMPS 40 HP | 2 | EA | 60.0 | 28.91 | 3,469 | 6,900.00 | 13,800 | 17,269 |
| CNDNSR PUMP 40 HP | 2 | EA | 60.0 | 28.91 | 3,469 | 6,900.00 | 13,800 | 17,269 |
| RETROFIT EXISTING CHILLER TO R-123 | 1 | JOB | | | | 35,000.00 | 35,000 | 35,000 |
| CHILLER PLANT MANIFOLD & VALVES | 1 | JOB | 133.0 | 28.91 | 3,845 | 9,600.00 | 9,600 | 13,445 |
| CENTRAL PLANT CONTROLS | 1 | JOB | 300.0 | 28.91 | 8,673 | 6,000.00 | 6,000 | 14,673 |
| | | | | SUBTOTAL | 129,799 | | 812,912 | 942,711 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-185.6K3

DATE: 9/19/96

ECO NO. K-3 Replace Existing Chillers

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED SCREW
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 129,468 | | 127,011 | 256,479 |
| SUB TOTAL FROM SHEET 2 | | | | | 129,799 | | 812,912 | 942,711 |
| SUBTOTAL | | | | | 259,267 | | 939,923 | 1,199,190 |
| O & P @ 20% | | | | | 51,853 | | 187,985 | 239,838 |
| SUBTOTAL | | | | | 311,120 | | 1,127,908 | 1,439,028 |
| DESIGN @ 6% | | | | | | | | 86,342 |
| SUBTOTAL | | | | | | | | 1,525,369 |
| SIOH @ 5.5% | | | | | | | | 83,895 |
| TOTAL | | | | | | | | $1,609,265 |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. K-4 Replace Existing Chillers

PROJECT NO: 03-0185.6K4

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW CHILLERS and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 1 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 1,483 | TON | 1.1 | 28.91 | 47,161 | 20.00 | 29,660 | 76,821 |
| RMV PUMP | 4 | EA | 6.0 | 28.91 | 694 | 50.00 | 200 | 894 |
| RMV COOLING TOWER | 1 | EA | 150.0 | 28.91 | 4,337 | 1,900.00 | 1,900 | 6,237 |
| RMV PACKAGE UNIT | 50 | TON | 1.5 | 28.91 | 2,168 | 500.00 | 25,000 | 27,168 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 6" | 200 | LF | 1.0 | 28.91 | 5,782 | 29.50 | 5,900 | 11,682 |
| 4" | 900 | LF | 0.8 | 28.91 | 19,514 | 19.55 | 17,595 | 37,109 |
| 3" | 1,800 | LF | 0.6 | 28.91 | 31,223 | 15.70 | 28,260 | 59,483 |
| 2-1/2" | 800 | LF | 0.5 | 28.91 | 11,564 | 13.33 | 10,664 | 22,228 |
| 2" | 400 | LF | 0.4 | 28.91 | 4,626 | 13.33 | 5,332 | 9,958 |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| | | | | SUBTOTAL | 129,468 | | 127,011 | 256,479 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6k4
**DATE:** 9/19/96

**ECO NO. K-4** Replace Existing Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 1 | LOC | 10.7 | 28.91 | 308 | 717.00 | 717 | 1,025 |
| CHILLER (YORK YG) WITH PIPING & VESELS | 1,140 | TON | 4.5 | 28.91 | 148,308 | 896.00 | 1,021,440 | 1,169,748 |
| AHU CH 2-PIPE WITH VALVES & PIPING | 50 | TON | 2.9 | 28.91 | 4,120 | 660.00 | 33,000 | 37,120 |
| PRIMARY PUMPS 40 HP | 2 | EA | 60.0 | 28.91 | 3,469 | 6,900.00 | 13,800 | 17,269 |
| CNDNSR PUMP 40 HP | 2 | EA | 60.0 | 28.91 | 3,469 | 6,900.00 | 13,800 | 17,269 |
| RETROFIT EXISTING CHILLER TO R-123 | 1 | JOB | | | | 35,000.00 | 35,000 | 35,000 |
| CHILLER PLANT MANIFOLD & VALVES | 1 | JOB | 133.0 | 28.91 | 3,845 | 9,600.00 | 9,600 | 13,445 |
| CENTRAL PLANT CONTROLS | 1 | JOB | 300.0 | 28.91 | 8,673 | 6,000.00 | 6,000 | 14,673 |
| | | | | SUBTOTAL | 172,643 | | 1,134,392 | 1,307,035 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. K-4 Replace Existing Chillers

PROJECT NO: 03-185.6K4

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: I NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SUB TOTAL FROM SHEET 1 | | | | | 129,468 | | 127,011 | 256,479 |
| SUB TOTAL FROM SHEET 2 | | | | | 172,643 | | 1,134,392 | 1,307,035 |
| SUBTOTAL | | | | | 302,111 | | 1,261,403 | 1,563,514 |
| O & P @ 20% | | | | | 60,422 | | 252,281 | 312,703 |
| SUBTOTAL | | | | | 362,534 | | 1,513,684 | 1,876,217 |
| DESIGN @ 6% | | | | | | | | 112,573 |
| SUBTOTAL | | | | | | | | 1,988,790 |
| SIOH @ 5.5% | | | | | | | | 109,383 |
| TOTAL | | | | | | | | $2,098,174 |


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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-0185.6MA

**DATE:** 9/19/96

**ECO NO. K** Retrofit Existing Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment
AREA 1300

**ANNUAL COSTS**

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON EXISTING | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER CHILLER PER YEAR | | | | | | | | |
| EXISTING WATER COOLEDCHILLERS | -3. | EA | 200.0 | 30.00 | -18,000 | 6,150.00 | -18,450 | -36,450 |
| EXISTING AIR COOLED CHILLERS | -44. | TON | 0.7 | 30.00 | -924 | 29.00 | -1,276 | -2,200 |
| EXISTING WINDOW UNITS | | EA | 3.0 | 30.00 | | 20.00 | | |
| EXISTING DX SYSTEM | -77.5 | TON | 1.0 | 30.00 | -2,325 | 5.00 | -388 | -2,713 |
| **NEW EQUIPMENT** | | | | | | | | |
| NEW WATER COOLED CHILLERS | 3. | EA | 190.0 | 30.00 | 17,100 | 6,150.00 | 4,020 | 21,120 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS | | | | | -4,149 | | -16,094 | -20,243 |
| PER YEAR | | | | | | | | |


**HUITT-ZOLLARS, INC.**
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Life Cycle Cost Analysis — Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-K1
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $1,106,604 |
| B. SIOH | $64,515 |
| C. Design Cost | $66,396 |
| D. Total Cost (1A+1B+1C) | $1,237,515 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $1,237,515 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 4,393 | Mbtus | $27,589 | 15.08 | $416,047 |
| Elec. Deman | | | | | $43,719 | 14.88 | $650,539 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 4,393 | Mbtus | $71,308 | | $1,066,585 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRI | $20,243 | Annual | 14.88 | $301,216 |
| ANNUAL TOTAL | $20,243 | | | $301,216 |
| REFRIGERANT RE | $3,944 | 0 | 1.0 | $3,944 |
| CHILLER RETROF | $70,000 | 0 | 1.0 | $70,000 |
| ONE TIME TOTAL | $73,944 | | | $73,944 |
| TOTAL | $94,187 | | | $375,160 |

| | |
|---|---|
| 4. First Year Dollar Savings | $95,249 |
| 5. Simple Payback Period (Years) | 12.99 |
| 6. Total Net Discounted Savings | $1,441,745 |
| 7. Savings to Investment Ratio | 1.17 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 3.79% |

Life Cycle Cost Analysis  Study: FSH-2.LC
Energy Conservation Investment Program (ECIP)  LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS  Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-K2
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $1,158,542 |
| B. SIOH | $67,543 |
| C. Design Cost | $69,513 |
| D. Total Cost (1A+1B+1C) | $1,295,598 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $1,295,598 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 4,721 | Mbtus | $29,648 | 15.08 | $447,090 |
| Elec. Deman | | | | | $42,465 | 14.88 | $631,879 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 4,721 | Mbtus | $72,113 | | $1,078,969 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRI | $20,243 | Annual | 14.88 | $301,216 |
| ANNUAL TOTAL | $20,243 | | | $301,216 |
| REFRIGERANT RE | $3,944 | 0 | 1.0 | $3,944 |
| CHILLER RETROF | $70,000 | 0 | 1.0 | $70,000 |
| ONE TIME TOTAL | $73,944 | | | $73,944 |
| TOTAL | $94,187 | | | $375,160 |

4. First Year Dollar Savings $96,053
5. Simple Payback Period (Years) 13.49
6. Total Net Discounted Savings $1,454,129
7. Savings to Investment Ratio 1.12
   If < 1, Project does not qualify
8. Adjusted Internal Rate of Return 3.6%

Life Cycle Cost Analysis Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-K3
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment
   - A. Construction Cost $1,439,028
   - B. SIOH $83,895
   - C. Design Cost $86,342
   - D. Total Cost (1A+1B+1C) $1,609,265
   - E. Salvage Value of Existing Equip. 0
   - F. Public Utility Company Rebate $0
   - G. Total Investment (1D-1E-1F) $1,609,265

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 3,169 | Mbtus | $19,899 | 15.08 | $300,074 |
| Elec. Deman | | | | | $28,829 | 14.88 | $428,976 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 3,169 | Mbtus | $48,728 | | $729,050 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRI | $20,243 | Annual | 14.88 | $301,216 |
| ANNUAL TOTAL | $20,243 | | | $301,216 |
| REFRIGERANT RE | $3,944 | 0 | 1.0 | $3,944 |
| CHILLER RETROF | $70,000 | 0 | 1.0 | $70,000 |
| ONE TIME TOTAL | $73,944 | | | $73,944 |
| TOTAL | $94,187 | | | $375,160 |

4. First Year Dollar Savings $72,668
5. Simple Payback Period (Years) 22.15
6. Total Net Discounted Savings $1,104,209
7. Savings to Investment Ratio .69
   If < 1, Project does not qualify
8. Adjusted Internal Rate of Return 1.08%

Life Cycle Cost Analysis    Study: FSH-2.LC
Energy Conservation Investment Program (ECIP)    LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS    Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-K4
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $1,876,217 |
| B. SIOH | $109,383 |
| C. Design Cost | $112,573 |
| D. Total Cost (1A+1B+1C) | $2,098,173 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | 0 |
| G. Total Investment (1D-1E-1F) | $2,098,173 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 9,083 | Mbtus | $57,040 | 15.08 | $860,163 |
| Elec. Deman | | | | | $74,012 | 14.88 | $1,101,299 |
| Natural Gas | $3.5 | /Mbtus | -15,872 | Mbtus | -$54,918 | 18.58 | -$1,020,373 |
| TOTAL | | | -6,789 | Mbtus | $76,134 | | $941,089 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRI | $20,243 | Annual | 14.88 | $301,216 |
| ANNUAL TOTAL | $20,243 | | | $301,216 |
| REFRIGERANT RE | $3,944 | 0 | 1.0 | $3,944 |
| CHILLER RETROF | $70,000 | 0 | 1.0 | $70,000 |
| ONE TIME TOTAL | $73,944 | | | $73,944 |
| TOTAL | $94,187 | | | $375,160 |

| | |
|---|---|
| 4. First Year Dollar Savings | $100,074 |
| 5. Simple Payback Period (Years) | 20.97 |
| 6. Total Net Discounted Savings | $1,316,248 |
| 7. Savings to Investment Ratio | .63 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | .63% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | L |
| DATE: | 3/1/95 |
| ECO TITLE: | Replace Existing Central Boilers With High Efficiency Modular Boilers |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 1300, Building 1377 (serves buildings 1350, 1374, 1375, 1377, 1379, 1380, 1382, 1385, 1385, 1396, and 1398) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 342 | MMBTU/yr |
| Electrical Demand Savings | 1256 | $/yr |
| Gas Energy Savings | 1064 | MMBTU/yr |
| Total Energy Savings | 1406 | MMBTU/yr |
| Total Cost Savings | 22,265 | $/yr |
| Total Investment | 484,544 | $ |
| Simple Payback | 21.8 | yrs |
| SIR | 0.71 | |

B. ECO Description:

Remove the existing boilers as listed in Table-1. Also remove the one 40 HP (serving Building 1350), and two 15 HP (serving Buildings 1374,75,79, 80, 82, and 85) HW distribution pumps in building 1377. Connect the two separate distribution loops together in Buildirg 1377 with new HW supply and return headers to make a single HW distribution system. Install four new modular high efficiency boilers (rated at 1830 MBH-output), stainless steel flue stacks, and regulator valve each and four new 7 ½ HP distribution pumps to serve this single system. The existing HW pumps of Buildings 1384, 1396, and 1398 will be reutilized as secondary pumps. A new 4" direct buried primary CHW supply and return piping loop will be constructed and connected with the new 470 gpm primary pump. This loop will require a 2.0" capped take-off that will serve Building 1387 (if needed for future use). The loop will have approximately 200 ft. of 4", 900 ft. of 3", 800 ft. of 2.0", 1800 ft. of 2.5" and 400 ft of 1.5" piping to complete this primary loop. All other building AHUs, HW coil three way control valves will be converted to two way valves to minimize pumping enegy. The existing electrical service and controls should be reused as much as possible. Specific requirements in these areas should be determined by the design engineer responsible for this project. The boilers and pumps should be sequenced to operate only as needed to maintain the supply water temperature set point of approximately 180°F. Specific requirements in these areas should be determined by the design engineer responsible for this project. This project will require engineering drawings and specifications, demolition and removal of the existing chillers and pumps, and installation of the new chillers, pumps, associated wiring and controls.

**Table-1**

| Bldg. # | Quantity | Description | Size MBH | Flow GPM | Estimated Pipe Size inches | Extimated Pipe Length Feet |
|---|---|---|---|---|---|---|
| 1377 | 2 | HW boiler | 11824 | 886 | | |
| 1377 | 1 | HW boiler | 5317 | 530 | | |
| 1377 | 1 | HW boiler | 4336 | 440 | | |
| 1384 | 1 | HW boiler | 3636 | 265 | 4 | 30 |
| 1396 | 1 | HW boiler | 427.1 | 60 | 2 | 800 |
| 1398 | 1 | HW boile | 381.8 | 45 | 1.5 | 800 |
| 1387 | 7 | heat pumps | 900 | 100 | | |
| Total | 14 | HW boiler | 26822 | 2326 | N/A | N/A |

C. Discussion:

The two existing watertube boilers serving building 1350 were installed in 1983 and are rated at 5,317 MBH and 4,336 MBH output capacity. The single 40 HP pump circulates HW from these boilers through building 1350. The two existing firetube boilers serving the other buildings in the 1300 area were installed in 1972 and are rated at 5,912 MBH output capacity each. Two 15 HP pumps circulate HW from these boilers to the seven other buildings listed above. Building1384 has a gas fired boiler which was installed in 1984. Building 1396 and 1398 each have a natural draft gas fired boilers installed in 1986. All these boilers appear to be in fair condition. However, the cost of maintaining these boilers is excessive. Therefore, it is recommended that four 2,000 MBH gas fired high efficiency modular HW boilers be installed. These boilers are 86% efficient under full load conditions, and reach upwards to 98% efficiency under part load conditions. Also, they have the capability to be staged to maintain these part load efficiencies by remote boiler control. In retrofit projects such as this, the size of the boilers make it very economical and justifiable because of their ease of installation. Moreover, with their turn-down ratio, they provide a wider range of staging capability with varying ambient temperatures. Four primary pumps will provide an additional flexibility in staging. Computer simulations of the buildings served by these bolers determined that the current combined capacity of 27,796 MBH is much more than is required to adequately heat the buildings[1]. The existing boilers are therefore operating at an inefficient, low load condition most of the time. Also, because of the constant flow rate requirements of the large boilers, excessive pumping energy is expended. By combining the two distribution systems together and staging the four new high efficiency modular boilers to operate only as needed, a substantial energy savings can be realized. Also, a decrease in the combined boiler output capacity to 6,800 MBH is recommended to more closely match the heating load in the eight buildings and reduce the associated pumping energy consumption. All other building AHUs, HW coil three way control valves will be converted to two way valves to minimize the pumping energy and for better distribution of the HW flow through the AHU coils.

D. Savings Calculations:

1. *Energy Consumption and Savings:*

The monthly peak demand and energy consumptions of the existing and proposed boilers and HW pumps were calculated using the Trace 600 computer program[2]. The buildings served by the existing

boilers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[3].

The four new high efficiency, modular type boilers modeled were rated at 1,830 MBH output each. Full and part load performance data from Aerco International were used in the computer simulations of the new boiler energy usages[4]. An equipment list with specific data on the new boilers and pumps used in the computer simulation is shown on page C-218.

Once the computer simulations of the existing and new boiler systems were completed, the total annual demand cost and energy consumption of the new systems were compared with that of the existing systems to determine the annual savings[5]. These savings calculations are shown on page C-219 Through C-220. The demand and energy savings values were used in the life cycle cost analysis for this ECO.

2. *Maintenance Cost Savings:*

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of boilers, to four modular boilers. The total maintenance cost savings from this ECO is estimated to be $15,180 per year as shown on page C-225. This figure was used in the life cycle cost analysis.

E. Cost Estimates

The total installation costs for this ECO were estimated on page C-221 through C-224 . These costs were used in the life cycle cost analysis.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the Life Cyde Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-226. The data from the life cycle cost analysis were included in the summary on page C-215.

## REFERENCES

1. See Appendix H for Area 1300 heating system load profile.
2. See Appendix H for computer model input assumptions and data, and energy consumption output data.
3. See Appendix G for building field data and existing HVAC system data.
4. See Appendix F for manufacturer's equipment performance data from Aerco International.
5. See Appendix A for utility cost analysis data, used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-L, FORT SAM HOUSTON, AREA 1300

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Hot Water Boiler | 4 | Aerco #KC-2000 GWB<br>natural draft, watertube<br>1830 MBH output | Area 1300 | New | 2,000 MBH |
| Heating Water Pump | 4 | Bell & Gossett<br>160 gpm, 120 ft<br>7.5 HP | Area 1300 | New | 5.60 KW |
| | | | | | |
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## 1300 AREA

| ITEM | ECO-L EXISTING BUILDING SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Bldg. 1350 HW blr (BLR-1) | | | | | | | | | | | | | | 20.5 |
| Bldg. 1350 HW pump (BLR-1) | 29.8 | 29.8 | | | | | | | | | | | 1,192 | |
| Bldg. 1350 BLR-1 controls | 0.1 | 0.1 | | | | | | | | | | | 5 | |
| Bldg. 1350 HW blr (BLR-2) | | | | | | | | | | | | | | |
| Bldg. 1350 HW pump (BLR-2) | | | | | | | | | | | | | | |
| Bldg. 1350 BLR-2 controls | | | | | | | | | | | | | | |
| Bldg. 1377 Plant HW BLR-1 | | | | | | | | | | | | | | 5,371.3 |
| HW pump (BLR-1) | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48,653 | |
| BLR-1 controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW pump (BLR-1) | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48,653 | |
| HW blr f.d. fan (BLR-1) | 7.5 | 7.5 | 7.5 | 7.5 | | | | | | | 7.5 | 7.5 | 32,580 | |
| Bldg. 1377 Plant HW BLR-2 | | | | | | | | | | | | | | |
| HW pump (BLR-2) | | | | | | | | | | | | | | |
| HW blr f.d. fan (BLR-2) | | | | | | | | | | | | | | |
| BLR-2 controls | | | | | | | | | | | | | | |
| Bldg. 1384 HW boiler | | | | | | | | | | | | | | 208.5 |
| Bldg. 1384 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 187 | |
| Bldg. 1396 HW boiler | | | | | | | | | | | | | | 636.5 |
| Bldg. 1396 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| Bldg. 1398 HW boiler | | | | | | | | | | | | | | 445.2 |
| Bldg. 1398 HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| | | | | | | | | | | | | | | |
| Totals | 60.2 | 60.2 | 30.3 | 30.3 | | | | | | | 30.3 | 30.3 | 132,899 | 6,682.0 |
| Rate ($/KW) | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 10.0 | 10.0 | 10.0 | 10.0 | 7.5 | 7.5 | 7.5 | | |
| Cost ($) | 451.5 | 451.5 | 227.3 | 227.3 | | | | | | | 227.3 | 227.3 | | |

Total Demand 1,812.0 $/yr

Total Energy 453.6 MMBTU/yr (electric)

Total Energy 6,682.0 MMBTU/yr (gas)

1300 AREA

| ITEM | ECO-L: INSTALL HIGH EFFICIENCY MODULAR BOILERS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| High % modular boiler # 1 | | | | | | | | | | | | | | 3,744 |
| HW pump | 5.6 | 5.6 | 5.6 | 5.6 | | | | | | | | 5.6 | 24,326 | |
| HW controls | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | | 0.1 | 543 | |
| High % modular boiler # 2 | | | | | | | | | | | | | | 1,343 |
| HW pump | 5.6 | 5.6 | | | | | | | | | | 5.6 | 4,878 | |
| HW controls | 0.1 | 0.1 | | | | | | | | | | 0.1 | 109 | |
| High % modular boiler # 3 | | | | | | | | | | | | | | 523 |
| HW pump | 5.6 | 5.6 | | | | | | | | | | 5.6 | 2,430 | |
| HW controls | 0.1 | 0.1 | | | | | | | | | | 0.1 | 54 | |
| High % modular boiler # 4 | | | | | | | | | | | | | | 8 |
| HW pump | 5.6 | 5.6 | | | | | | | | | | | 252 | |
| HW controls | 0.1 | 0.1 | | | | | | | | | | | 6 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 22.8 | 22.8 | 5.7 | 5.7 | | | | | | | | 17.1 | 32,598 | 5,618 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 171 | 171 | 43 | 43 | | | | | | | | 128 | | |

| | | |
|---|---|---|
| Total Demand | 556 $/yr | |
| Demand Savings | 1,256 $/yr | |
| Energy Savings | 342 MMBTU/yr | (electric) |
| Energy Savings | 1,064 MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6L | | DATE: 9/19/96 |
| ECO NO. L Replace Existing Central Boilers AREA 1300 | BY : KOTHMANN, K | | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install NEW Central Plant BOILER HVAC Equipment
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 1 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| REMOVE BOILER | 5 | EA | 160.0 | 28.91 | 23,128 | 780.00 | 3,900 | 27,028 |
| RMV HW PUMPS | 4 | EA | 5.0 | 28.91 | 578 | 50.00 | 200 | 778 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 4" | 200 | LF | 0.8 | 28.91 | 4,626 | 19.55 | 3,910 | 8,536 |
| 3" | 900 | LF | 0.6 | 28.91 | 15,611 | 15.70 | 14,130 | 29,741 |
| 2" | 800 | LF | 0.4 | 28.91 | 9,251 | 13.33 | 10,664 | 19,915 |
| 2-1/2" | 1,800 | LF | 0.5 | 28.91 | 26,019 | 13.33 | 23,994 | 50,013 |
| 1-1/2" | 400 | LF | 0.4 | 28.91 | 4,626 | 12.85 | 5,140 | 9,766 |
| | | | | SUBTOTAL | 83,839 | | 61,938 | 145,777 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6L

**DATE:** 9/19/96

**ECO NO. L** Replace Existing Central Boilers AREA 1300

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX | 2 | EA | 10.0 | 28.91 | 578 | 540.00 | 1,080 | 1,658 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 120.0 | 20.00 | 2,400 | 2,500.00 | 2,500 | 4,900 |
| SERVICE VALVES , HOT WTR ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING HW PUMPS PER LOCATION | | | | | | | | |
| 2-1/2" | 3 | LOC | 9.6 | 28.91 | 833 | 639.00 | 1,917 | 2,750 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 100 | LF | 0.5 | 28.91 | 1,446 | 7.05 | 705 | 2,151 |
| ALL AIR SIDE EQUIPMENT INCLUDED IN ECO K | | | | | | | | |
| ADD PIPING ASSEMBLY &HOT WTR COIL | | | | | | | | |
| AHU 2-PIPE | 1 | EA | 30.0 | 28.91 | 867 | 3,500.00 | 3,500 | 4,367 |
| CHANGE ALL 3-WAY CONTROL VALVES TO 2-WAY | 1 | JOB | 300.0 | 28.91 | 8,673 | 16,000.00 | 16,000 | 24,673 |
| | | | | SUBTOTAL | 14,797 | | 25,702 | 40,499 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FT SAM HOUSTON , SAN ANTONIO TEX

**PROJECT NO:** 03-185.6L

**DATE:** 9/19/96

**ECO NO. L** Replace Existing Central Boilers AREA 1300

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant BOILER and HVAC Equipment
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install New Boiler AERCO # KC 2000 1830 MBH | 4 | EA | 100.00 | 28.91 | 11,564 | 18500.00 | 74,000 | 85,564 |
| BOILER ROOM PIPING AND VALVES | 1 | JOB | 240.00 | 28.91 | 6,938 | 5600.00 | 5,600 | 12,538 |
| Install New Pump 7.5 HP | 4 | EA | 15.00 | 28.91 | 1,735 | 2800.00 | 11,200 | 12,935 |
| pipe Assembly & valves Boiler | 4 | EA | 28.00 | 28.91 | 3,238 | 2400.00 | 9,600 | 12,838 |
| pipe Assembly & valves Pump | 4 | EA | 12.00 | 28.91 | 1,388 | 1350.00 | 5,400 | 6,788 |
| Boiler Breaching | 4 | JOB | 50.00 | 28.91 | 5,782 | 2500.00 | 10,000 | 15,782 |
| Controls | 1 | JOB | 160.00 | 28.91 | 4,626 | 6900.00 | 6,900 | 11,526 |
| Electrical | 1 | JOB | 100.00 | 28.91 | 2,891 | 5900.00 | 5,900 | 8,791 |
| Test , Balance & Start-up | 1 | LS | 160.00 | 28.91 | 4,626 | | | 4,626 |
| | | | | SUBTOTAL | 42,787 | | 128,600 | 171,387 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. L Replace Existing Central Boilers AREA 1300

PROJECT NO: 03-185.6L

DATE: 9/19/96

BY: KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant BOILER and HVAC Equipment
705164 Bldg SF Condition Space AREA 1300

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , HW ENTRY PIPING ASSEMBLY 1" | 2 | LOC | 14.0 | 28.91 | 809 | 1,300.00 | 2,600 | 3,409 |
| AND NEW HOT WTR PUMPS COST PER LOCATION | | | | | | | | |
| ALL AIR SIDE EQUIPMENT INCLUDED IN ECO K | | | | | | | | |
| SUB TOTAL FROM SHEET 1 | | | | | 83,839 | | 61,938 | 145,777 |
| SUB TOTAL FROM SHEET 2 | | | | | 14,797 | | 25,702 | 40,499 |
| SUB TOTAL FROM SHEET 3 | | | | | 42,787 | | 128,600 | 171,387 |
| SUBTOTAL | | | | | 142,232 | | 218,840 | 361,072 |
| O & P @ 20% | | | | | 28,446 | | 43,768 | 72,214 |
| SUBTOTAL | | | | | 170,678 | | 262,608 | 433,286 |
| DESIGN @ 6% | | | | | | | | 25,997 |
| SUBTOTAL | | | | | | | | 459,283 |
| SIOH @ 5.5% | | | | | | | | 25,261 |
| TOTAL | | | | | | | | $484,544 |


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# ENGINEER'S ESTIMATE OF MAINTENANCE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. L Retrofit Existing BOILERS

PROJECT NO: 03-0185.6MA

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment AREA 1300

ANNUAL COSTS

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | TOTAL PER YR | Unit Price | TOTAL PER YR | |
| **EXISTING EQUIPMENT** | | | | | | | | |
| MAINTENANCE COSTS ARE BASED ON | | | | | | | | |
| OUTSIDE CONTRACT COSTS PER BOILER PER YEAR | | | | | | | | |
| EXISTING BOILER | -6. | EA | 100.0 | 30.00 | -18,000 | 1,800.00 | -10,800 | -28,800 |
| **NEW EQUIPMENT** | | | | | | | | |
| AERCO MODULAR HIGH EFFICIENCY HW BOILER | 4. | EA | 80.0 | 30.00 | 9,600 | 1,500.00 | 4,020 | 13,620 |
| COSTS ARE PRORATED OVER TEN YEARS | | | | | | | | |
| TO INCLUDE WARRANTY PERIOD | | | | | | | | |
| NET SAVINGS PER YEAR | | | | | -8,400 | | -6,780 | -15,180 |

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Life Cycle Cost Analysis
Study: FSH-2.LC
Energy Conservation Investment Program (ECIP)
LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-L
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $433,286 |
| B. SIOH | $25,261 |
| C. Design Cost | $25,997 |
| D. Total Cost (1A+1B+1C) | $484,544 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $484,544 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 342 | Mbtus | $2,148 | 15.08 | $32,388 |
| Elec. Deman | | | | | $1,256 | 14.88 | $18,689 |
| Natural Gas | $3.5 | /Mbtus | 1,064 | Mbtus | $3,681 | 18.58 | $68,401 |
| TOTAL | | | 1,406 | Mbtus | $7,085 | | $119,479 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURR | $15,180 | Annual | 14.88 | $225,878 |
| ANNUAL TOTAL | $15,180 | | | $225,878 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $15,180 | | | $225,878 |

| | |
|---|---|
| 4. First Year Dollar Savings | $22,265 |
| 5. Simple Payback Period (Years) | 21.76 |
| 6. Total Net Discounted Savings | $345,357 |
| 7. Savings to Investment Ratio | .71 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 1.27% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | M |
| DATE: | 3/1/96 |
| ECO TITLE: | Install Energy Management System (EMS) For HVAC System |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 2200, (serves Buildings 2200, 2244, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272, and 2273) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 5002 | MMBTU/yr |
| Electrical Demand Savings | -1740 | $/yr |
| Gas Energy Savings | 124 | MMBTU/yr |
| Total Energy Savings | 5126 | MMBTU/yr |
| Total Cost Savings | 30,102 | $/yr |
| Total Investment | 889,460 | $ |
| Simple Payback | 29.6 | yrs |
| SIR | 0.51 | |

B. ECO Description:

Install an Energy Management System (EMS) at the central maintenance facility. The EMS will accomplish the following tasks for the equipment listed in Table-1 in all of the buildings as listed above:

1. All AHU's serving buildings in the table below will be furnished with all necessary controls to facilitate an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode, which will save thermal cooling energy. (several damaged OA dampers require repairs). Buildings 2200, 2263, 2264, 2265 and 2266 are included in this option.

2. An optimum start and stop program will be provided to control AHU's, chillers, boilers, CHW and HW pumps. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings will occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will energize as required to maintain a preset unoccupied space temperature. Building 2200, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272 and 2273 will have this option. All other buildings are not included.

3. All multi-zone units and all single zone units with or without reheat coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures after the reheat coil will be monitored. The cooling coil

leaving air temperature will be reset to satisfy at least one zone thermostat without reheat. Buildings 2263, 2264, 2265 and 2266 are included in this option.

4. All multi-zone units will have air side temperature reset. AHU heating supply air temperature will be reset sufficiently to satisfy at least one zone thermostat calling for full heat (at least one zone damper will be fully open). Buildings 2263, 2264, 2265 and 2266 are included in this option.

5. A night / day setback program will be provided to control window units and fan coil units, and split systems. The program will set back the temperature of the controlled space to a predetermined set-point during periods of no occupancy. Several space or unit mounted temperature sensors will be installed to control the units that currently are controlled under manual operation or no control.

**Table-1**

| Building Number | Equipment To Be Controlled |
|---|---|
| 2200 | 4 AHUs and 12 FCUs, Chiller, CHW pump, Boiler and HW pump. |
| 2244 | 1 DX AHU, 1 Condenser |
| 2247 | 1 AHU, A/C comp, CW pump, Boiler and HW pump CLG. tower and 2 window units. |
| 2248 | 1 AHUs and 7 FCUs, Chiller, CHW pump, Boiler and HW pump. |
| 2250 | 2 AHUs and HW pump. |
| 2263 | 8 AHUs, 14 FCUs |
| 2264 | 10 AHUs. |
| 2265 | 10 AHUs. (Chiller, boiler, CW, CHW, HW, boiler circulation pumps are located in this building.) |
| 2266 | 10 AHUs |
| 2270 | 1 AHU, 3 A/C comp, CW pump, 2 Boilers, HW pump and CLG. tower. |
| 2272 | 1 AHUs, Chiller, CHW pump, Boiler and HW pump. |
| 2273 | 20 FCUs |

C. Discussion:

1. Generally, the ambient condition in San Antonio area is warm and humid. Annual free cooling hours will be limited. A large number of AHUs are equipped with necessary dampers to support an economizer cycle. The original HVAC system was designed to have an economizer cycle, or a smoke purge system. All OA and RA dampers will be repaired and retrofitted with necessary controls to support an economizer cycle. In appropriate ambient conditions, these units will operate in the economizer mode. When the enthalpy of the OA drops below the RA, then the OA damper will open, and the RA damper will close. This action will reduce the cooling energy required. The benefit of this system will occur only in the cooling mode. In the heating mode, the OA damper will remain in the preset minimum open position to permit necessary ventilation. Buildings 2200, 2263, 2264, 2265 and 2266 are included in this option. Four AHUs in Building 2200 will be retrofitted in this Option. Due to existing conditions and locations of AHUs in rest of the buildings, they will not be retrofitted in this option.

2. Regardless of occupancy hours, all AHU's are operated 24 hours per day, 365 days per year to maintain space temperature. However, the chillers operate only during the cooling season as do the boilers in the heating season. Depending on occupancy schedules, ambient conditions and building thermal characteristics, most AHU's and their associated chillers, boilers , CHW and HW pumps will be turned off daily in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHU's will remain off during weekends and holidays.

Several temperature sensors will be installed in the spaces served by these AHU's. These sensors will monitor the space temperature during unoccupied hours. During the cooling season when the space temperature exceeds 85 F, the AHU's and their associated cooling auxiliaries serving that space will energize to cool the space below 85 F. When the space temperature reaches 84 F, they will cycle off. Similarly, the winter time unoccupied period space temperature will be maintained at 65 F.

The EMS system will have the capability to manually override this operation with a change in schedule. All AHU's serving the critical areas such as the computer room will operate as usual, and they will not be connected to the new start/stop program. However, if desired, their current operation and performance can be monitored by the new EMS system.

3. Currently all multi-zone units are delivering cooling supply air at a preset cooling coil leaving air temperature. The room temperature is controlled by mixing cold and hot air in the AHU's. (Boiler and chiller have a seasonal operation, hot and cold air mixing never occurs, return air mixes with cold air in the summer and with hot air in winter.) In both cases, cooling and heating energy is wasted. To reduce this waste currently the hot air plenum is acting as a return air plenum. Our observations indicate that all zones are mixing cold supply and return air to maintain the room or zone temperatures. By resetting the cooling supply air to a higher temperature, additional cooling energy savings will occur. The same control sequence will be applied to the hot deck temperature control.

In multi-zone units, cooling supply air temperatures at the unit and zone temperatures after the mixing damper will be monitored. Excessively high zone temperatures indicate the mixing of cold supply and return air. When this occurs in all zones, the supply air temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. (A 1.0 F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.). The space humidity also will be monitored. When the humidity exceeds its upper limit, the cooling supply air temperature will be decreased to provide dehumidification. Buildings 2263, 2264, 2265 and 2266 are included in this option as they have a multi-zone system.

4. Currently all multi-zone units are delivering heating supply air at a preset heating coil leaving air temperature. The room temperature is controlled by mixing return and hot air in the AHU's. Our observations indicate that all zones are mixing hot supply and return air to maintain the room or designated zone area temperatures during the winter season. By resetting the heating supply air to a lower temperature, additional heating energy savings will occur. Heating supply air temperature will be lowered until at least one zone

damper will remains fully open to satisfy the room or area heating demand. Many partially open heating dampers indicate a higher than necessary heating deck temperature. Lowering the temperature will save heating energy. Buildings 2263, 2264, 2265 and 2266 are included in this option as they have a multi-zone system.

5. During periods when the facility remains unoccupied, the window units, fan coil units and split systems that serve non-critical areas will be reset to an "unoccupied" space temperature condition. Temperature sensors will monitor the space temperature at all times, and when the program determines the unoccupied periods, the temperature set point will rise from 78°F to 85°F for summer cooling conditions and from 70°F to 65°F for winter cooling conditions. When the space temperature exceeds 85°F during unoccupied periods, then it will energize the unit and its associated auxiliary cooling equipment. Similarly, when the space temperature falls below 65°F during unoccupied periods, then it will energize the unit and its associated auxiliary heating equipment.

   The EMS will have the capability to override this operation with a change in schedule or function. Also, this will not apply to window units, fan coil units, and split systems serving critical areas such as computer rooms. These units will operate as usual, and they will connected to the new start stop program unless their operation and performance needs to be monitored.

   The EMS system will be controlled by a personal computer (PC) located in the central maintenance building. All other buildings control panels will be connected to the central EMS system PC in the Building via telephone lines.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumption of the existing and proposed EMS system were calculated using the Trace 600 computer program[1]. The buildings served by the existing chillers were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations of the existing and new EMS system were completed, the total annual demand cost and energy consumption were compared with that of the existing and new systems to determine the annual savings for this ECO[3]. These savings calculations are shown on pages C-234 and C-237. These demand and energy savings values were used in the life cycle cost analysis.

2. *Maintenance Cost Savings:*

There was no maintenance cost savings by this retrofit.

E. Cost Estimates:

The total installation costs for the new EMS system are estimated on pages C-238 through C-240. These costs were estimated from the I/O point list shown on pages C-232 through C-233 and used in the life cycle cost analysis.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. A summary sheet for this life cycle cost analysis is shown on page C-241. The data from the summary sheet were presented in the ECO summary on page C-227.

## REFERENCES

1. Refer to Appendix H for system thermal load profile, input assumptions, and computer model output.

2. Refer to Appendix G for building data and existing HVAC equipment data.

3. Refer to Appendix A for utility cost analysis and avoided costs calculations.

| AREA: 2200 | HARDWARE | | | | | | | | | | | | | | | | | | | | | | |
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| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | |
| ECO M: INSTALL EMS FOR HVAC EQUIPMENT<br>OCCUPANCY TIME: VARIES<br>GRAPHIC DISPLAY ●<br>POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE |
| | | | | | | | | | | | | | | | | | | | | | | | |
| W/C CHILLER ● | | | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 1 | | | | | | | | | | | | | | | | 1 | | |
| CHW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | | | |
| CW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | | | |
| TWR. FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | | | | | | |
| CW SUPPLY HEADER | | | | | | | | | | | | | | | | | | | | | | | |
| CW RETURN HEADER | | | | | | | | | | | | | | | | | | | | | | | |
| TWR. BYPASS VALVE | | | | | | | | | | | | | | | | | | | | | | | |
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| A/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 3 | | | | | | | | | | | | | | | | 3 | | |
| CHW PUMP | 3 | | | | | | | | | | | | | | 3 | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 3 | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 3 | | | | | |
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| CONDENSER / FLUID COOLER ● | | | | | | | | | | | | | | | | | | | | | | | |
| FAN | 3 | | | | | | | | | | | | | | 3 | | | | | | | | |
| CW SUPPLY HEADER | | | | | | | | | | | | | | | | | | | | | | | |
| CW RETURN HEADER | | | | | | | | | | | | | | | | | | | | | | | |
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| HW BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 4 | | | | | | | 4 | | | | | | | | | | | |
| HW PUMP | 4 | | | | | | | | | | | | | | 4 | | | | | | | | |
| HW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 4 | | | | | |
| HW RETURN HEADER | | | | | | | | | | | | | | | | | | 4 | | | | | |
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| HW BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 6 | | | | | | | 6 | | | | | | | | | | | |
| HW PUMP | 6 | | | | | | | | | | | | | | 6 | | | | | | | | |
| HW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 1 | | | | | |
| HW RETURN HEADER | | | | | | | | | | | | | | | | | | 1 | | | | | |
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| AHU-SZ ● | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 18 | | | | | | | | | | | | | | 18 | | | | | | | | |
| CHW COIL VALVE | | | | | | 18 | | | | | | | | | | | | 18 | | | | | |
| HW COIL VALVE | | | | | | 18 | | | | | | | | | | | | 18 | | | | | |
| RETURN AIR | | | | | | | 18 | | | | | | | | | | | 18 | | | | | |
| FILTER | | | | | | | | | | 18 | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 18 | | | | | |
| OUTSIDE AIR | | | | | | | 18 | | | | | | | | | | | | | | | | |

| | | | | | | SOFTWARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| ANALOG | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | | | |
| WATTS | GAGE PRESSURE | DIFFERENITAL PRESSURE | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | | | | |
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| REMOTE BOILER CONTROL | RUN TIME | KW | KWH | | | | REMARKS |
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| | | | | | | | |
| | | | | | | | one chiller serving bldgs. 2263, 2264, 2265, |
| | X | | | | | | & 2266 |
| | X | | | | | | |
| | X | | | | | | with the age of this chiller, it is not advisable |
| | X | | | | | | to add any controls to the CHW system |
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| | | | | | | | serves bldgs. 2200, 2248, 2250, 2272, & |
| | X | | | | | | 2273 |
| | X | | | | | | |
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| | | | | | | | serves bldgs. 2244, 2247, & 2270 |
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| | | | | | | | serves bldgs. 2263, 2264, 2265, & 2266 |
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| | | | | | | | |
| | | | | | | | serves bldgs. 2200, 2244, 2247, 2248, 2270, |
| | | | | | | | 2272, & 2273 |
| | X | | | | | | with the age of the boilers, it is not advisable |
| | | | | | | | to add any controls to the HW system for |
| | | | | | | | the boilers serving the following bldgs. |
| | | | | | | | 2244, 2247, 2248, 2270, 2272, 2273 |
| | | | | | | | |
| | X | | | | | | all valves, dampers, thermostats, and |
| | | | | | | | actuators are existing. |
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| AREA: 2200 | HARDWARE | | | | | | | | | | | | | | | | | | | | | | |
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| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | |
| ECO M: INSTALL EMS FOR HVAC EQUIPMENT<br>OCCUPANCY TIME: VARIES | | | | | | | | | | | | | | | | | | | | | | | |
| GRAPHIC DISPLAY ● | | | | | | | | | | | | | | | | | | | | | | | |
| POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE |
| | | | | | | | | | | | | | | | | | | | | | | | |
| AHU (MZ) ● | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 30 | | | | | | | | | | | | | | 30 | | | | | | | | |
| COLD DECK TEMP. | | | | | | 30 | | | | | | | | | | | | 30 | | | | | |
| HOT DECK TEMP. | | | | | | 30 | | | | | | | | | | | | 30 | | | | | |
| RETURN AIR | | | | | | | 30 | | | | | | | | | | | 30 | | | | | |
| OUTSIDE AIR | | | | | | | 30 | | | | | | | | | | | | | | | | |
| ZONE DAMPERS | | | | | | | 120 | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 120 | | | | | |
| FILTER | | | | | | | | | | 30 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| FAN COIL UNIT ● | | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 43 | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| PACKAGED AHU ● | | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 2 | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| OUTSIDE AIR ● | | | | | | | | | | | | | | | | | | 1 | 1 | | | | |
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TOTAL AO POINTS = 81

TOTAL DO POINTS = 312

TOTAL AI POINTS = 125

TOTAL DI POINTS = 354

GRAND TOTAL POINTS = 872

NOTES:

1. It is not recommended to install any controls for steam boiler serving 2247 due to the age and deterioration of the equipment.

| | | | | | | | SOFTWARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | |
| ANALOG | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AMPS | WATTS | GAGE PRESSURE | DIFFERENITAL PRESSURE | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | [illegible] | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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pment.

| LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | all valves, dampers, thermostats, and |
| | | X | | | | | | actuators are existing. |
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2200 AREA

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (2263-2266) | | | | | 538.1 | 573.9 | 594.1 | 600.1 | 581.7 | 410.6 | | | 908,553 | |
| Cooling Tower (2263-2266) | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 120,368 | |
| CHW Pump (2263-2266) | | | | | 74.6 | 74.6 | 74.6 | 74.6 | 74.6 | 74.6 | | | 329,433 | |
| CW Pump (2263-2266) | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 164,717 | |
| CHW controls (2263-2266) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| A/C chiller (2200) | 28.3 | 28.3 | 36.8 | 54.5 | 75.0 | 78.8 | 81.6 | 81.0 | 75.7 | 49.6 | 36.3 | 28.3 | 118,315 | |
| CHW pump (2200) | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 10,705 | |
| CHW controls (2200) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 4,866 | |
| CHW Condensing unit (2244) | 13.9 | 13.4 | 17.0 | 19.7 | 24.2 | 26.9 | 29.2 | 29.0 | 25.8 | 20.0 | 165.7 | 13.6 | 88,789 | |
| CHW Condenser fans (2244) | 0.7 | 0.6 | 1.3 | 1.6 | 1.9 | 2.1 | 2.9 | 2.9 | 2.0 | 1.7 | 1.3 | 0.7 | 6,705 | |
| CHW controls (2244) | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 2,485 | |
| CHW Condensing unit (2247) | 19.8 | 19.3 | 25.5 | 30.2 | 34.2 | 34.7 | 35.5 | 35.8 | 35.0 | 29.1 | 25.5 | 20.3 | 72,917 | |
| CHW Condenser fans (2247) | 0.9 | 0.8 | 1.2 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.2 | 0.9 | 2,891 | |
| CW pump (2247) | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 8,079 | |
| CHW controls (2247) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 539 | |
| A/C chiller (2248) | | | | | 60.6 | 67.0 | 72.2 | 71.5 | 62.5 | 47.4 | | | 122,882 | |
| CHW pump (2248) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | | 13,248 | |
| CHW controls (2248) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| CHW pump (2248) | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 6,624 | |
| CHW Condensing unit (2270) | | | | | 80.7 | 82.6 | 83.7 | 84.5 | 82.6 | 45.0 | | | 125,222 | |
| CHW Condenser fans (2270) | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 1.1 | | | 3,063 | |
| CW pump (2270) | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| CHW controls (2270) | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 442 | |
| A/C chiller (2272,73) | | | | | 35.6 | 38.9 | 42.0 | 41.9 | 37.9 | 31.0 | | | 73,197 | |
| CHW pump (2272, 73) | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| CHW controls (2272, 73) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 2263 fans | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 261,048 | |
| Bldg. 2264 fans | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 552,324 | |
| Bldg. 2265 fans | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 689,253 | |
| Bldg. 2266 fans | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 689,253 | |
| Bldg. 2200 fans | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 30,762 | |
| Bldg. 2200 fans | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 131,292 | |
| Bldg. 2244 fans | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 19,272 | |
| Bldg. 2247 fans | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 109,051 | |
| Bldg. 2248 fans | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 45,552 | |
| Bldg. 2250 fans | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 45,552 | |
| Bldg. 2270 fans | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 130,524 | |
| Bldg. 2272 fans | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 103,821 | |
| Bldg. 2273 fans | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 5,256 | |
| HW boiler (2263) blr-1 | | | | | | | | | | | | | | 1,568 |
| HW pump (2263) blr-1 | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48653.0 | |
| HW controls (2263) blr-1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW pump (2263) blr-1 | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| HW boiler (2263) blr-2 | | | | | | | | | | | | | | 28 |
| HW pump (2263) blr-2 | 11.2 | 11.2 | | | | | | | | | | 11.2 | 1,154 | |
| HW controls (2263) blr-2 | 0.1 | 0.1 | | | | | | | | | | 0.1 | 13 | |

# 2200 AREA

| ITEM | EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| HW pump (2263) blr-2 | 0.6 | 0.6 | | | | | | | | | | 0.6 | 70 | |
| HW boiler (2263) blr-3 | | | | | | | | | | | | | | |
| HW pump (2263) blr-3 | | | | | | | | | | | | | | |
| HW controls (2263) blr-3 | | | | | | | | | | | | | | |
| HW pump (2263) blr-3 | 0.6 | 0.6 | | | | | | | | | | 0.6 | 12 | |
| HW boiler (2200) | | | | | | | | | | | | | | 727 |
| HW pump (2200) | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 6,516 | |
| HW controls (2200) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 543 | |
| HW boiler (2244) | | | | | | | | | | | | | | |
| HW pump (2244) | | | | | | | | | | | | | | |
| HW controls (2244) | | | | | | | | | | | | | | |
| HW pump (2244) | | | | | | | | | | | | | | |
| Steam boiler (2247) | | | | | | | | | | | | | | 158 |
| Steam boiler controls (2247) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW boiler (2248,50) | | | | | | | | | | | | | | 144 |
| HW pump (2248,50) | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 501 | |
| HW controls (2248,50) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 313 | |
| HW pump (2248,50) | 0.3 | 0.3 | 0.3 | 0.3 | | | | | | | 0.3 | 0.3 | 1,303 | |
| HW boiler (2270) blr-1 | | | | | | | | | | | | | | 1,396 |
| HW pump (2270) blr-1 | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 9,557 | |
| HW controls (2270) blr-1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW boiler (2270) blr-2 | | | | | | | | | | | | | | 3 |
| HW pump (2270) blr-2 | | 2.2 | | | | | | | | | | 2.2 | 191 | |
| HW controls (2270) blr-2 | | 0.1 | | | | | | | | | | 0.1 | 11 | |
| HW boiler (2272,73) | | | | | | | | | | | | | | 112 |
| HW pump (2272,73) | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 9,380 | |
| HW controls (2272,73) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 317 | |
| | | | | | | | | | | | | | | |
| Totals | 422.7 | 423.8 | 428.4 | 454.0 | 1338.6 | 1393.2 | 1429.5 | 1435.0 | 1391.5 | 1121.5 | 576.6 | 425.2 | 5,125,522 | 4,134 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 3,170 | 3,179 | 3,213 | 3,405 | 10,040 | 13,932 | 14,295 | 14,350 | 13,915 | 8,411 | 4,325 | 3,189 | | |

| | | | |
|---|---|---|---|
| Total Demand | 95,423 | $/yr | |
| Total Energy | 17,493 | MMBTU/yr | (electric) |
| Total Energy | 4,134 | MMBTU/yr | (gas) |

# 2200 AREA

| ITEM | ECO M - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (2263-2266) | | | | | 572.0 | 579.7 | 594.1 | 600.1 | 586.1 | 418.5 | | | 1,089,786 | |
| Cooling Tower (2263-2266) | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 120,817 | |
| CHW Pump (2263-2266) | | | | | 74.6 | 74.6 | 74.6 | 74.6 | 74.6 | 74.6 | | | 329,433 | |
| CND Pump (2263-2266) | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 164,717 | |
| CHW controls (2263-2266) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| A/C chiller (2200) | 26.2 | 26.2 | 34.7 | 55.3 | 75.4 | 78.8 | 81.6 | 81.0 | 75.7 | 51.6 | 37.6 | 26.2 | 78,396 | |
| CHW pump (2200) | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 10,597 | |
| CHW controls (2200) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 4,817 | |
| CHW Condensing unit (2244) | 13.9 | 13.4 | 17.0 | 19.7 | 24.2 | 26.9 | 29.2 | 29.0 | 25.8 | 20.0 | 16.7 | 13.6 | 88,789 | |
| CHW Condenser fans (2244) | 0.7 | 0.6 | 1.3 | 1.6 | 1.9 | 2.1 | 2.9 | 2.9 | 2.0 | 1.7 | 1.3 | 0.7 | 6,705 | |
| CHW controls (2244) | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 2,485 | |
| CHW Condensing unit (2247) | 19.8 | 22.4 | 27.5 | 31.9 | 34.2 | 34.7 | 35.5 | 35.8 | 35.0 | 31.5 | 29.5 | 24.0 | 61,080 | |
| CHW Condenser fans (2247) | 0.9 | 0.8 | 1.3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0.9 | 2,622 | |
| CND pump (2247) | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 8,037 | |
| CHW controls (2247) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 536 | |
| A/C chiller (2248) | | | | | 66.5 | 69.5 | 72.1 | 71.5 | 66.8 | 58.1 | | | 84,785 | |
| CHW pump (2248) | | | | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | | | 13,248 | |
| CHW controls (2248) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| CHW pump (2248) | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | | | 6,624 | |
| CHW Condensing unit (2270) | | | | | 80.7 | 82.6 | 83.7 | 84.5 | 82.6 | 42.4 | | | 61,043 | |
| CHW Condenser fans (2270) | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 1.0 | | | 1,667 | |
| CND pump (2270) | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| CHW controls (2270) | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 442 | |
| A/C chiller (2272,73) | | | | | 34.7 | 37.8 | 41.0 | 40.9 | 37.0 | 33.2 | | | 48,189 | |
| CHW pump (2272, 73) | | | | | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | | | 16,339 | |
| CHW controls (2272, 73) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| Bldg. 2263 fans | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 96,075 | |
| Bldg. 2264 fans | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 63.1 | 344,421 | |
| Bldg. 2265 fans | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 347,659 | |
| Bldg. 2266 fans | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 78.7 | 347,659 | |
| Bldg. 2200 fans | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 11,322 | |
| Bldg. 2200 fans | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 43,284 | |
| Bldg. 2244 fans | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 19,272 | |
| Bldg. 2247 fans | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 35,799 | |
| Bldg. 2248 fans | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 15,688 | |
| Bldg. 2250 fans | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 15,688 | |
| Bldg. 2270 fans | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 35,815 | |
| Bldg. 2272 fans | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 34,449 | |
| Bldg. 2273 fans | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1,728 | |
| HW boiler (2263) blr-1 | 30.0 | 30.0 | 21.8 | 1.8 | | | | | | | 21.0 | 30.0 | | 3,051 |
| HW pump (2263) blr-1 | 11.2 | 11.2 | 11.2 | 11.2 | | | | | | | 11.2 | 11.2 | 48,653 | |
| HW controls (2263) blr-1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW pump (2263) blr-1 | 0.6 | 0.6 | 0.6 | 0.6 | | | | | | | 0.6 | 0.6 | 2,433 | |
| HW boiler (2263) blr-2 | 24.2 | 25.0 | | | | | | | | | | 23.6 | | 48 |
| HW pump (2263) blr-2 | 11.2 | 11.2 | | | | | | | | | | 11.2 | 224 | |
| HW controls (2263) blr-2 | 0.1 | 0.1 | | | | | | | | | | 0.1 | 3 | |

# 2200 AREA

| ITEM | ECO M - INSTALL EMS FOR HVAC EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| HW pump (2263) blr-2 | 0.6 | 0.6 | | | | | | | | | | 0.6 | 13 | |
| HW boiler (2263) blr-3 | | | | | | | | | | | | | | |
| HW pump (2263) blr-3 | | | | | | | | | | | | | | |
| HW controls (2263) blr-3 | | | | | | | | | | | | | | |
| HW pump (2263) blr-3 | | 0.6 | | | | | | | | | | | 2 | |
| HW boiler (2200) | 5.6 | 6.2 | 2.5 | 0.2 | | | | | | | 2.2 | 6.2 | | 226 |
| HW pump (2200) | 1.5 | 1.5 | 1.5 | 1.5 | | | | | | | 1.5 | 1.5 | 6,516 | |
| HW controls (2200) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW boiler (2244) | | | | | | | | | | | | | | |
| HW pump (2244) | | | | | | | | | | | | | | |
| HW controls (2244) | | | | | | | | | | | | | | |
| HW pump (2244) | | | | | | | | | | | | | | |
| Steam boiler (2247) | 2.0 | 2.0 | 0.2 | 0.2 | | | | | | | 0.7 | 2.0 | | 94 |
| Steam boiler controls (2247) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW boiler (2248,50) | 4.2 | 4.2 | 0.2 | 0.2 | | | | | | | 1.4 | 4.2 | | 99 |
| HW pump (2248,50) | 0.2 | 0.2 | 0.2 | 0.2 | | | | | | | 0.2 | 0.2 | 448 | |
| HW controls (2248,50) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 280 | |
| HW pump (2248,50) | 0.3 | 0.3 | 0.3 | 0.3 | | | | | | | 0.3 | 0.3 | 1,303 | |
| HW boiler (2270) blr-1 | 7.5 | 7.5 | 5.1 | 0.4 | | | | | | | 5.6 | 7.5 | | 427 |
| HW pump (2270) blr-1 | 2.2 | 2.2 | 2.2 | 2.2 | | | | | | | 2.2 | 2.2 | 9,557 | |
| HW controls (2270) blr-1 | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 543 | |
| HW boiler (2270) blr-2 | 1.6 | 2.5 | | | | | | | | | | 2.4 | | 4 |
| HW pump (2270) blr-2 | 2.2 | 2.2 | | | | | | | | | | 2.2 | 51 | |
| HW controls (2270) blr-2 | 0.1 | 0.1 | | | | | | | | | | 0.1 | 3 | |
| HW boiler (2272,73) | 2.6 | 2.6 | 1.7 | 0.2 | | | | | | | 2.2 | 2.6 | | 62 |
| HW pump (2272,73) | 3.7 | 3.7 | 3.7 | 3.7 | | | | | | | 3.7 | 3.7 | 8,281 | |
| HW controls (2272,73) | 0.1 | 0.1 | 0.1 | 0.1 | | | | | | | 0.1 | 0.1 | 280 | |
| | | | | | | | | | | | | | | |
| Totals | 500.0 | 504.8 | 459.9 | 459.6 | 1376.3 | 1398.8 | 1426.8 | 1432.4 | 1397.7 | 1142.5 | 466.3 | 504.7 | 3,659,819 | 4,010 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 3,750 | 3,786 | 3,449 | 3,447 | 10,322 | 13,988 | 14,268 | 14,324 | 13,977 | 8,569 | 3,497 | 3,785 | | |

| | | | |
|---|---|---|---|
| Total Demand | 97,163 | $/yr | |
| Demand Savings | -1,740 | $/yr | |
| Energy Savings | 5,002 | MMBTU/yr | (electric) |
| Energy Savings | 124 | MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| **LOCATION:** FORT SAM HOUSTON , SAN ANTONIO,TX | **PROJECT NO:** 03-0185.06M | **DATE:** 9/19/96 |
| **ECO NO. M AREA 2200** | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J. |

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | HRS/ UNIT | Rate | Total | Unit Price | Total | |
| EMCS COSTS BASED ON DDC ALL ELECTRIC | | | | | | | | |
| DEVICES INCLUDING COMMON COSTS,CONDUIT & WIRE | | | | | | | | |
| DIGITAL OUTPUT DEVICE : | | | | | | | | |
| START-STOP MOTOR | 67 | EA | 10.2 | 28.91 | 19,757 | 175.74 | 11,775 | 31,532 |
| ENABLE/DISABLE APPARATUS RELAY | 14 | EA | 4.5 | 28.91 | 1,821 | 49.00 | 686 | 2,507 |
| ANALOG OUTPUT: | | | | | | | | |
| CONTROL VALVE (COIL/AHU ACTUATOR ONLY) | 96 | EA | 11.9 | 28.91 | 33,082 | 571.00 | 54,816 | 87,898 |
| DAMPER ACTUATOR & MOTOR | 216 | EA | 11.9 | 28.91 | 74,435 | 340.00 | 73,440 | 147,875 |
| DIGITAL INPUT: | | | | | | | | |
| DIFFERENTIAL PREASURE SWITCH | 48 | EA | 10.1 | 28.91 | 14,016 | 227.30 | 10,910 | 24,926 |
| AUXILIARY CONTACT | 10 | EA | 4.5 | 28.91 | 1,301 | 49.00 | 490 | 1,791 |
| CURRENT SENSING RELAY | 67 | EA | 4.5 | 28.91 | 8,716 | 49.00 | 3,283 | 11,999 |
| SHEET 1 | | | | | | | | |
| | | | | SUBTOTAL | 153,129 | | 155,400 | 308,529 |
| | | | O & P @ 20% | | | | | |
| | | | | SUBTOTAL | | | | |
| | | | DESIGN @ 6% | | | | | |
| | | | | SUBTOTAL | | | | |
| | | | SIOH @ 5.5% | | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX

ECO NO. M AREA 2200

PROJECT NO: 03-0185.06M

BY : KOTHMANN, K

DATE: 9/19/96

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | | Hrs / Unit | Rate | Total | Unit Price | Total | |
| ANALOG INPUT: | | | | | | | | |
| TEMP. SENSER & THERMO WELL | 52 | EA | 17.0 | 28.91 | 25,556 | 426.42 | 22,174 | 47,730 |
| TEMP. SENSER AIR DUCT | 108 | EA | 12.0 | 28.91 | 37,467 | 450.00 | 48,600 | 86,067 |
| TEMP. SENSER OUTSIDE AIR | 1 | EA | 12.0 | 28.91 | 347 | 550.00 | 550 | 897 |
| TEMP. SENSER ZONE | 183 | EA | 12.0 | 28.91 | 63,486 | 556.00 | 101,748 | 165,234 |
| RELATIVE HUMIDITY % | 1 | EA | 13.0 | 28.91 | 376 | 615.00 | 615 | 991 |
| AMPERES | 4 | EA | 7.0 | 28.91 | 809 | 219.00 | 876 | 1,685 |
| GAUGE PRESURE BOILER | | | | 28.91 | | | | |
| FLOW STATUS / RATE | 4 | EA | 17.0 | 28.91 | 1,966 | 410.00 | 1,640 | 3,606 |
| EQUIPMENT FAILURE ALARM | 19 | EA | 2.6 | 28.91 | 1,428 | 108.00 | 2,052 | 3,480 |
| FILTER ALARM | 1 | EA | 4.5 | 28.91 | 130 | 227.00 | 227 | 357 |
| HIGH & LOW LIMIT (HYDRONIC) | 34 | PR | 2.0 | 28.91 | 1,966 | 170.00 | 5,780 | 7,746 |
| SHEET 2 | | | | | | | | |
| | | | | SUBTOTAL | 133,532 | | 184,262 | 317,794 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO,TX | PROJECT NO: 03-0185.06M | DATE: 9/19/96 |
| ECO NO. M AREA 2200 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

**PROJECT DESCRIPTION:** Install EMCS System for HVAC Equipment
Bldg SF Condition Space

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| OPERATORS' WORKSTATION | 1 | SUM | | | | 13,184.00 | 13,184 | 13,184 |
| INCLUDING MODEM & REMOTE PANEL | | | | | | | | |
| SUBMITTALS, TRAINING & START-UP | 1 | JOB | | | | 8,300.00 | 8,300 | 8,300 |
| SOFTWARE | 1 | LS | | | | 15,000.00 | 15,000 | 15,000 |
| SUB TOTAL FROM SHEET 1 | | | | | 153,129 | | 155,400 | 308,529 |
| SUB TOTAL FROM SHEET 2 | | | | | 133,532 | | 184,262 | 317,794 |
| | | | | SUBTOTAL | 286,661 | | 376,146 | 662,807 |
| | | | | O & P @ 20% | 57,332 | | 75,229 | 132,561 |
| | | | | SUBTOTAL | 343,993 | | 451,375 | 795,368 |
| | | | | DESIGN @ 6% | | | | 47,722 |
| | | | | SUBTOTAL | | | | 843,090 |
| | | | | SIOH @ 5.5% | | | | 46,370 |
| | | | | TOTAL | | | | $889,460 |

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Life Cycle Cost Analysis — Study: FSH-2.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS — Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-M
Analysis Date: 09/19/96 Economic Life: 20 years
Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $795,368 |
| B. SIOH | $46,370 |
| C. Design Cost | $47,722 |
| D. Total Cost (1A+1B+1C) | $889,460 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $889,460 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 5,002 | Mbtus | $31,413 | 15.08 | $473,701 |
| Elec. Deman | | | | | -$1,740 | 14.88 | -$25,891 |
| Natural Gas | $3.5 | /Mbtus | 124 | Mbtus | $429 | 18.58 | $7,972 |
| TOTAL | | | 5,126 | Mbtus | $30,102 | | $455,782 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $30,102 |
| 5. Simple Payback Period (Years) | 29.55 |
| 6. Total Net Discounted Savings | $455,782 |
| 7. Savings to Investment Ratio | .51 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | -.39% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | N |
| DATE: | 3/1/95 |
| ECO TITLE: | Replace Existing Central Chillers With New Electric Centrifugal Chillers |
| INSTALLATION: | Fort Sam Houston, San Antonio, Texas |
| LOCATION: | Area 2200, Building 2265 (serves buildings 2200, 2244, 2247, 2248, 2250, 2263, 2264, 2265, 2266, 2270, 2272, and 2273) |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 3050 | MMBTU/yr |
| Electrical Demand Savings | 25,570 | $/yr |
| Gas Energy Savings | 0 | MMBTU/yr |
| Total Energy Savings | 3050 | MMBTU/yr |
| Total Cost Savings | 55,110 | $/yr |
| Total Investment | 1,040,094 | $ |
| Simple Payback | 18.9 | yrs |
| SIR | 0.80 | |

B. ECO Description:

Remove the existing 675 ton, R-11 centrifugal chiller in building 2265 and associated CHW pump, CW pump, and cooling tower. Remove the air cooled chillers serving Buildings 2200, 2248/2250, and 2272/2273. Remove the water cooled reciprocating chiller, condenser, and two window units from Building 2247 and replace air handling equipment with two 1.5 ton CHW fan/coil units. Building 2270's condenser pump and existing cooling tower will be removed and the AHU DX coil unit will be retrofitted with a CHW coil, and a new secondary CHW pump. Also, the DX coil serving Building 2244 will need to be retrofitted to CHW, and the condenser removed. The existing central plant of Building 2200 will be expanded. The north wall will be removed and additional 750 sq ft. space will be added. Install two new water cooled centrifugal R-123 refrigerant chillers including one 270 ton, and one 545 ton chiller. Also provide one 20 HP (fan), and one 25 HP (fan) cooling tower. The chillers will be on a common 10" supply header, and switch-over control will be utilized to maintain maximum efficiency. Provide two 40 HP CHW pumps, one 20 HP CW pump, and one 40 HP CW pump. A new CHW distribution loop will need to be constructed which includes installing two separate loops. One 10" branch take-off from the CHW supply and return headers will be routed underground (direct buried) to the existing loop mains serving buildings 2263, 2264, 2265, and 2266 which are outside of the mechanical room in building 2265. A second 3" take-off will be extended underground from the plant to remainder of the buildings . Approximately 100 ft. of 10", 700 ft. of 3", and 400 ft of 2.5" under ground piping will be required for these loop. The 4" main piping will split into two 3" branches. All existing building CHW pumps will be reutilized as secondary pumps All new CHW coils will be retrofitted with new two way control valves. A 2.5" by-pass valve will be installed in the plant to maintain a set minimum deferential pressure between CHW supply and return lines and to insure the safe operation of the chiller. All existing controls and electrical services should be reconnected where possible. Specific requirements in these areas should be determined by the design engineer responsible for this project. To meet the current ASHRAE Standard 15, a refrigerant detection and ventilation system should be installed. This project will require engineering drawings and specifications, demolition and removal of the existing chiller and installation of the new chiller, associated wiring and controls.

C. Discussion:

All cooling equipment is located at different locations, remote to each other. Buildings 2247 and 2270 cooling systems are very old and poor condition; and thus, require frequent maintenance They all are reciprocating chillers. Chillers at the other buildings beside Building2265, 2247 and 2270 appear to be in fair condition. The existing water cooled, centrifugal chiller located in Builling 2265 was installed in 1973 and appears to be in poor condition. All of the existingwater cooled equipment except Building 2247 (R-12) utilizes R-11 as it's refrigerant, which willno longer be manufactured as of January 1, 1996[1]. To avoid the anticipated increasing operational costs over the life of this machine, they should either be retrofitted to use an approved refrigerant or replaced with a new machine that operates on one. The existing centrifugal machines can be retrofitted to an approved refrigerant by modifying the impeller, gears, etc... However, the technology is not currently availabe to retrofit these units without a 3%-5% loss in efficiency and 5%-7% loss in tonnage. Moreover,the cost of maintaining these smaller older building systems is excessive. Therefore, since the older machines are already over twenty years old ~~and retrofitting them~~ would create a greater loss in efficiency, it is recommended that the facility replace them instead. A life cycle cost analysis performed on four different types of replacement chillers available determined that an electric centrifugal chiller using R-134a would be the most economical choice over the life of the new machine. Computer simulations of the buildings served by this machine determined that the current installed capacity of 904 tons is more than what is required to adequately cool the buildings[2]. Therefore, the new chillers should be sized for a total load of 815 tons to more closely match the cooling load of the buildings.

D. Savings Calculations:

1. *Energy Consumption And Savings*

The monthly peak demand and energy consumptions of the existing and proposed alternative chillers and auxiliary equipment were calculated using the Trace 600 computer program[3]. The buildings served by the existing chiller were modeled by the computer to provide a realistic load profile. Field data obtained from the buildings were used to create these computer building models[4].

The multiple chiller alternatives which were compared included an electric centrifugal machine, an electric centrifugal with a variable frequency drive, a screw machine and a gas driven centrifugal machine. All proposed machines used R-123 or R-134a. Full load performance data from York International, and default part load curves were used in the computer simulations of the new chiller energy usages. Equipment lists of the specific chillers and auxiliaries for each alternative modeled by the computer are shown on pages C-246 To C-249.

Once the computer simulations were completed, the total annual demand cost and energy consumption of each alternative were compared with that of the existing systems to determine the annual savings for each[5]. These savings calculations are shown on pages C-250 through C-252. The demand and energy savings values were used in the life cycle cost analysis for each alternative. The results of these savings calculations were as follows:

| Alternative | Chiller Type | Demand Savings $/yr | Electrical Savings MMBTU/yr | Gas Savings MMBTU/yr |
|---|---|---|---|---|
| **N1** | Electric Centrifugal | 25,570 | 3050 | 0 |
| **N2** | Electric Centrifugal & VFD | 25,345 | 3370 | 0 |
| **N3** | Electric Screw | 22,010 | 2842 | 0 |
| **N4** | Gas Driven Centrifugal | 49,038 | 4826 | -8229 |

2. *Maintenance Cost Savings*:

Maintenance cost estimates were prepared using a maintenance cost data from manufacturers and was used to estimate the maintenance savings from reducing the total number of water cooled chillers in this area to three water cooled chillers. The total maintenance cost savings for this ECO as shown on page C-273 is estimated to be $8005 per year. This figure was used in the life cycle cost analysis.

E. Cost Estimates

The total installation costs for each alternative chiller mentioned in this ECO were estimated on pages C-253 through C-272. These costs were used in the life cycle cost analysis for each alternative. The results of the costs estimates were as follows:

| Alternative | Chiller Type | Estimated Cost |
|---|---|---|
| **N1** | Electric Centrifugal | $1,040,094 |
| **N2** | Electric Centrifugal & VFD | $1,080,752 |
| **N3** | Electric Screw | $1,089,311 |
| **N4** | Gas Driven Centrifugal | $1,659,208 |

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on each chiller alternative for this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. By installing the new centrifugal chillers, the installation will save the cost of retrofitting the three R-11 machines for the HCFC-123 refrigerant as mentioned previously. The cost of this retrofit was estimated to be $45,000 and shown as a non-recurring cost associated with this ECO. Moreover, there is a second non-recurring cost associated with the reclaim value of the refrigerant R-11. This cost was estimated at $2.00 per pound of R-11 and 2 pounds per ton resulting in a total cost of $2,628. A summary sheet for each life cycle cost analysis is shown on pages C-274 through C-277. The results of the alternative life cycle cost analysis were as follows:

| Alternative | Chiller Type | Payback Years | SIR |
|---|---|---|---|
| **N1** | Electric Centrifugal | 18.9 | 0.80 |
| **N2** | Electric Centrifugal & VFD | 19.0 | 0.80 |
| **N3** | Electric Screw | 21.6 | 0.70 |
| **N4** | Gas Driven Centrifugal | 27.1 | 0.50 |

Since the electric centrifugal chiller has the highest SIR and lowest payback period, it is recommended as the most economical choice to replace the existing machine. The data from the life cycle cost analysis for this alternative were included in the summary on page C-242.

REFERENCES


1. Per current EPA regulations on CFC refrigerants.
2. See Appendix H for Area 2200 cooling system load profile.
3. See Appendix H for computer model input assumptions and data, and energy consumption output data.
4. See Appendix G for building field data and existing HVAC system data.
5. See Appendix A for utility cost analysis data, used in the savings calculations.

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-N1, FORT SAM HOUSTON, AREA 2200

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YT<br>water cooled, centrifugal,<br>270 tons, R-123a | Area 2200 | New | 154 KW |
| Chilled Water Pump | 1 | Bell and Gossett<br>540 gpm, 110 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Condenser Water Pump | 1 | Bell and Gossett<br>810 gpm, 70 ft<br>20 HP | Area 2200 | New | 14.90 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, 1 cell<br>20HP fans | Area 2200 | New | 14.90 KW |
| Water Chiller | 1 | York YT<br>water cooled, centrifugal,<br>545 tons, R-123a | Area 2200 | New | 300 KW |
| Chilled Water Pump | 1 | Bell and Gossett<br>1090 gpm, 110 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Condenser Water Pump | 1 | Bell and Gossett<br>1635 gpm, 70 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, 1 cell<br>25 HP fans | Area 2200 | New | 18.60 KW |
| | | | | | |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-N2, FORT SAM HOUSTON, AREA 2200

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YT, electric, VFD<br>water cooled, centrifugal<br>270 tons, R-123 | Area 2200 | New | 154 KW |
| Chilled Water Pump | 1 | Bell and Gossett<br>540 gpm, 110 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Condenser Water Pump | 1 | Bell and Gossett<br>810 gpm, 70 ft<br>20 HP | Area 2200 | New | 14.90 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, 1 cell<br>20HP fans | Area 2200 | New | 14.90 KW |
| Water Chiller | 1 | York YT, electric, VFD<br>water cooled, centrifugal,<br>545 tons, R-123 | Area 2200 | New | 300 KW |
| Chilled Water Pump | 1 | Bell and Gossett<br>1090 gpm, 110 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Condenser Water Pump | 1 | Bell and Gossett<br>1635 gpm, 70 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, 1 cell<br>25 HP fans | Area 2200 | New | 18.60 KW |
| | | | | | |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-N3, FORT SAM HOUSTON, AREA 2200

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York YS<br>water cooled screw<br>270 tons | Area 2200 | New | 167 KW |
| Chilled Water Pump | 1 | Bell and Gossett<br>540 gpm, 110 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Condenser Water Pump | 1 | Bell and Gossett<br>810 gpm, 70 ft<br>20 HP | Area 2200 | New | 14.90 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, 1 cell<br>20HP fans | Area 2200 | New | 14.90 KW |
| Water Chiller | 1 | York YS<br>water cooled screw<br>545 tons | Area 2200 | New | 349 KW |
| Chilled Water Pump | 1 | Bell and Gossett<br>1090 gpm, 110 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Condenser Water Pump | 1 | Bell and Gossett<br>1635 gpm, 70 ft<br>40 HP | Area 2200 | New | 29.80 KW |
| Cooling Tower | 1 | Evapco AT<br>crossflow, 1 cell<br>25 HP fans | Area 2200 | New | 18.60 KW |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-N4, FORT SAM HOUSTON, AREA 2200

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | York, gas engine driven YG<br>water cooled, centrifugal<br>815 tons, R-134a | Area 2200 | New | 5,379 MBH |
| Chilled Water Pump | 1 | Bell and Gossett<br>1630 gpm, 110 ft<br>60 HP | Area 2200 | New | 44.70 KW |
| Condenser Water Pump | 1 | Bell and Gossett<br>2690 gpm, 70 ft<br>60 HP | Area 2200 | New | 44.70 KW |
| Cooling Tower<br>2-speed fan | 1 | Evapco AT<br>crossflow, 1 cell<br>50 HP fan | Area 2200 | New | 37.20 KW |
| | | | | | |
| | | | | | |
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| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

PROPOSED HVAC EQUIPMENT LIST FOR: ECO-O, FORT SAM HOUSTON, AREA 2200

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Hot Water Boiler | 3 | Aerco #KC-2000 GWB<br>natural draft, watertube<br>1830 MBH output | Area 2200 | New | 2,000 MBH |
| Heating Water Pump | 3 | Bell and Gossett<br>172 gpm, 150 ft<br>15 HP | Area 2200 | New | 11.20 KW |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

2200 AREA

| ITEM | ECO N - EXISTING BUILDING EQUIPMENT MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller (2263-2266) | | | | | 538.1 | 573.9 | 594.1 | 600.1 | 581.7 | 410.6 | | | 908,553 | |
| Cooling Tower (2263-2266) | | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | 120,368 | |
| CHW Pump (2263-2266) | | | | | 74.6 | 74.6 | 74.6 | 74.6 | 74.6 | 74.6 | | | 329,433 | |
| CW Pump (2263-2266) | | | | | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | | | 164,717 | |
| CHW controls (2263-2266) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| A/C chiller (2200) | 28.3 | 28.3 | 36.8 | 54.5 | 75.0 | 78.8 | 81.6 | 81.0 | 75.7 | 49.6 | 36.3 | 28.3 | 118,315 | |
| CHW controls (2200) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 4,866 | |
| CHW Condensing unit (2244) | 13.9 | 13.4 | 17.0 | 19.7 | 24.2 | 26.9 | 29.2 | 29.0 | 25.8 | 20.0 | 165.7 | 13.6 | 88,789 | |
| CHW Condenser fans (2244) | 0.7 | 0.6 | 1.3 | 1.6 | 1.9 | 2.1 | 2.9 | 2.9 | 2.0 | 1.7 | 1.3 | 0.7 | 6,705 | |
| CHW controls (2244) | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 2,485 | |
| CHW Condensing unit (2247) | 19.8 | 19.3 | 25.5 | 30.2 | 34.2 | 34.7 | 35.5 | 35.8 | 35.0 | 29.1 | 25.5 | 20.3 | 72,917 | |
| CHW Condenser fans (2247) | 0.9 | 0.8 | 1.2 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.2 | 0.9 | 2,891 | |
| CHW controls (2247) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 539 | |
| A/C chiller (2248) | | | | | 60.6 | 67.0 | 72.2 | 71.5 | 62.5 | 47.4 | | | 122,882 | |
| CHW controls (2248) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| CHW Condensing unit (2270) | | | | | 80.7 | 82.6 | 83.7 | 84.5 | 82.6 | 45.0 | | | 125,222 | |
| CHW Condenser fans (2270) | | | | | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 1.1 | | | 3,063 | |
| CHW controls (2270) | | | | | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | | | 442 | |
| A/C chiller (2272,73) | | | | | 35.6 | 38.9 | 42.0 | 41.9 | 37.9 | 31.0 | | | 73,197 | |
| CHW controls (2272, 73) | | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 4,416 | |
| | | | | | | | | | | | | | | |
| Totals | 65.0 | 63.8 | 83.2 | 108.8 | 1000.2 | 1054.8 | 1091.1 | 1096.6 | 1053.1 | 783.1 | 231.4 | 65.2 | 2,158,632 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 488 | 479 | 624 | 816 | 7,502 | 10,548 | 10,911 | 10,966 | 10,531 | 5,873 | 1,736 | 489 | | |

| | | | |
|---|---|---|---|
| Total Demand | 60,961 | $/yr | |
| Total Energy | 7,367 | MMBTU/yr | (electric) |
| Total Energy | | MMBTU/yr | (gas) |

| ITEM | ECO-N1: NEW ELECTRIC CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller | 25.9 | 24.6 | 31.3 | 41.7 | 145.9 | 148.3 | 152.7 | 154.6 | 150.3 | 130.0 | 31.1 | 25.8 | 187,162 | |
| Cooling Tower Fans | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | 46,986 | |
| CHW Pump | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 196,173 | |
| CW Pump | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 98,087 | |
| CHW controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 6,583 | |
| Water Chiller | | | | 284.6 | 288.9 | 297.6 | 301.2 | 292.8 | 261.2 | | | | 540,670 | |
| Cooling Tower Fans | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | | 44,491 | |
| CHW Pump | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 71,282 | |
| CW Pump | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 71,282 | |
| CHW controls | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 2,392 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 71.6 | 70.3 | 91.9 | 466.1 | 574.6 | 585.7 | 593.7 | 587.2 | 551.3 | 190.6 | 91.7 | 71.5 | 1,265,108 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 537 | 527 | 689 | 3,496 | 4,310 | 5,857 | 5,937 | 5,872 | 5,513 | 1,430 | 688 | 536 | | |

| | | | |
|---|---|---|---|
| Total Demand | 35,391 | $/yr | |
| Demand Savings | 25,570 | $/yr | |
| Energy Savings | 3,050 | MMBTU/yr | (electric) |
| Energy Savings | | MMBTU/yr | (gas) |

| ITEM | ECO-N2: NEW ELECTRIC CENTRIFUGAL CHILLER WITH VFD MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller | 21.8 | 20.3 | 28.6 | 36.7 | 154.0 | 154.0 | 154.0 | 154.9 | 154.0 | 153.7 | 28.3 | 21.8 | 154,748 | |
| Cooling Tower Fans | | | | | 10.9 | 11.8 | 13.5 | 14.9 | 12.6 | 11.5 | | | 5,000 | |
| CHW Pump | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 196,173 | |
| CW Pump | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 98,087 | |
| CHW controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 6,563 | |
| Water Chiller | | | | 300.0 | 300.0 | 300.0 | 301.7 | 300.0 | 300.0 | | | | 540,171 | |
| Cooling Tower Fans | | | | 13.6 | 14.7 | 16.9 | 18.6 | 15.7 | 11.8 | | | | 25,637 | |
| CHW Pump | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 71,282 | |
| CW Pump | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 71,282 | |
| CHW controls | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 2,392 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 67.5 | 66.0 | 74.3 | 456.6 | 585.9 | 589.0 | 594.1 | 591.8 | 584.7 | 210.9 | 74.0 | 67.5 | 1,171,335 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 506 | 495 | 557 | 3,425 | 4,394 | 5,890 | 5,941 | 5,918 | 5,847 | 1,582 | 555 | 506 | | |

| | | | |
|---|---|---|---|
| Total Demand | 35,616 | $/yr | |
| Demand Savings | 25,345 | $/yr | |
| Energy Savings | 3,370 | MMBTU/yr | (electric) |
| Energy Savings | | MMBTU/yr | (gas) |

| ITEM | ECO-N3: NEW ELECTRIC SCREW CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller | 31.8 | 30.8 | 35.8 | 41.7 | 159.0 | 161.4 | 165.7 | 167.0 | 163.3 | 143.3 | 35.9 | 31.8 | 177,906 | |
| Cooling Tower Fans | | | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | | 46,920 | |
| CHW Pump | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 196,173 | |
| CW Pump | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 14.9 | 98,087 | |
| CHW controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 6,583 | |
| Water Chiller | | | | 332.6 | 337.2 | 346.2 | 349.0 | 341.2 | 308.3 | | | | 610,843 | |
| Cooling Tower Fans | | | | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | | | | 44,491 | |
| CHW Pump | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 71,282 | |
| CND Pump | | | | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | 29.8 | | | | 71,282 | |
| CHW controls | | | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | 2,392 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 77.5 | 76.5 | 96.4 | 514.1 | 636.0 | 647.4 | 654.5 | 648.0 | 611.4 | 203.9 | 96.5 | 77.5 | 1,325,959 | |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 581 | 574 | 723 | 3,856 | 4,770 | 6,474 | 6,545 | 6,480 | 6,114 | 1,529 | 724 | 581 | | |

| | | | |
|---|---|---|---|
| Total Demand | 38,951 | $/yr | |
| Demand Savings | 22,010 | $/yr | |
| Energy Savings | 2,842 | MMBTU/yr | (electric) |
| Energy Savings | | MMBTU/yr | (gas) |

| ITEM | ECO-N4: NEW GAS ENGINE CENTRIFUGAL CHILLER MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL ENERGY USAGE (MCF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Water Chiller | | | | | | | | | | | | | | 8,229 |
| Cooling Tower | | | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | 37.2 | | 167,687 | |
| CHW Pump | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 285,276 | |
| CW Pump | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 44.7 | 285,276 | |
| CHW controls | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 6,382 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 90.4 | 90.4 | 127.6 | 127.6 | 127.6 | 127.6 | 127.6 | 127.6 | 127.6 | 127.6 | 127.6 | 90.4 | 744,621 | 8,229 |
| Rate ($/KW) | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | 10.00 | 10.00 | 10.00 | 10.00 | 7.50 | 7.50 | 7.50 | | |
| Cost ($) | 678 | 678 | 957 | 957 | 957 | 1,276 | 1,276 | 1,276 | 1,276 | 957 | 957 | 678 | | |

| | | | |
|---|---|---|---|
| Total Demand | 11,923 | $/yr | |
| Demand Savings | 49,038 | $/yr | |
| Energy Savings | 4,826 | MMBTU/yr | (electric) |
| Energy Savings | -8,229 | MMBTU/yr | (gas) |

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-0185.6N1

**DATE:** 9/19/96

**ECO NO. N-1** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
AREA 2200

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 670 | TON | 1.5 | 28.91 | 29,829 | 25.00 | 16,750 | 46,579 |
| RMV CHILLER UP TO 50 TON | 100 | TON | 1.6 | 28.91 | 4,655 | 25.00 | 2,500 | 7,155 |
| REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED | 2 | EA | 1.5 | 22.00 | 66 | 50.00 | 100 | 166 |
| RMV DIRECT EXPANSION CONDENSER & AHU | 2 | EA | 5.0 | 28.91 | 289 | 50.00 | 100 | 389 |
| RMV COOLING TOWER | 675 | TON | 0.3 | 20.00 | 4,050 | 3.00 | 2,025 | 6,075 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 10" | 100 | LF | 1.8 | 28.91 | 5,204 | 56.50 | 5,650 | 10,854 |
| 4" | 10 | LF | 0.8 | 28.91 | 217 | 19.55 | 196 | 412 |
| 3" | 700 | LF | 0.6 | 28.91 | 12,142 | 15.70 | 10,990 | 23,132 |
| 2-1/2" | 400 | LF | 0.5 | 28.91 | 5,551 | 13.33 | 5,332 | 10,883 |
| | | | | SUBTOTAL | 62,002 | | 43,643 | 105,645 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6N1

**DATE:** 9/19/96

**ECO NO. N-1** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
AREA 2200

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX | 4 | EA | 2.1 | 28.91 | 241 | 590.00 | 2,360 | 2,601 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 200.0 | 20.00 | 4,000 | 3,000.00 | 3,000 | 7,000 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 3 | LOC | 10.7 | 28.91 | 924 | 717.00 | 2,151 | 3,075 |
| ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE, | | | | | | | | |
| PIPING ASSEMBLY & ELECTRICAL CONNECTION | | | | | | | | |
| AHU W/ CHW COIL 2-PIPE | 2 | EA | 54.0 | 28.91 | 3,122 | 6,400.00 | 12,800 | 15,922 |
| | | | | SUBTOTAL | 8,737 | | 21,346 | 30,083 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. N-1 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6N1

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
AREA 2200

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| EXPAND CENTRAL PLANT BASE BUILDING | 750 | BSF | | | | 75.00 | 56,250 | 56,250 |
| HISTORICALLY COMPATIBLE | | | | | | | | |
| COOLING TOWER ENCLOSURE | 1 | SUM | 1.0 | 9,000.00 | 9,000 | 12,000.00 | 12,000 | 21,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 750 | BSF | | | | 34.00 | 25,500 | 25,500 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 815 | TON | 3.2 | 28.91 | 75,397 | 371.00 | 302,365 | 377,762 |
| PRIMARY PUMPS 40 HP | 1 | EA | 60.0 | 28.91 | 1,735 | 7,500.00 | 7,500 | 9,235 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 815 | TON | 0.6 | 28.91 | 14,137 | 92.00 | 74,980 | 89,117 |
| 10" PIPING MANIFOLD AND VALVES | 1 | JOB | 170.0 | 28.91 | 4,915 | 5,700.00 | 5,700 | 10,615 |
| | | | | SUBTOTAL | 105,184 | | 484,295 | 589,479 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6N1
**DATE:** 9/19/96

**ECO NO. N-1** Retrofit Existing Individual Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
AREA 2200

| ITEM DESCRIPTION SHEET 4 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND NEW CHW PUMPS COST PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 21.2 | 28.91 | 613 | 2,417.00 | 2,417 | 3,030 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 100 | EA | 0.5 | 28.91 | 1,446 | 7.05 | 705 | 2,151 |
| 1-1/2" | 50 | EA | 0.4 | 28.91 | 578 | 5.05 | 253 | 831 |
| 1" | 50 | EA | 0.3 | 28.91 | 434 | 4.38 | 219 | 653 |
| 3/4" | 100 | EA | 0.3 | 28.91 | | 2.75 | | |
| SUBTOTAL | | | | | 3,070 | | 3,594 | 6,664 |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| TOTAL | | | | | | | | |


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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6N1

**DATE:** 9/19/96

**ECO NO. N-1** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL
AREA 2200

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, | 2 | EA | 4.8 | 28.91 | 275 | 1,375.00 | 2,750 | 3,025 |
| CONTROL VALVE AND ELECTRIC CIRCUIT | | | | | | | | |
| CHANGE 3-WAY CONTROL VALVES TO 2-WAY | 71 | EA | 4.0 | 28.91 | 8,210 | 450.00 | 31,950 | 40,160 |
| SUB TOTAL FROM SHEET 1 | | | | | 62,002 | | 43,643 | 105,645 |
| SUB TOTAL FROM SHEET 2 | | | | | 8,737 | | 21,346 | 30,083 |
| SUB TOTAL FROM SHEET 3 | | | | | 105,184 | | 484,295 | 589,479 |
| SUB TOTAL FROM SHEET 4 | | | | | 3,070 | | 3,594 | 6,664 |
| SUBTOTAL | | | | | 187,479 | | 587,577 | 775,056 |
| O & P @ 20% | | | | | 37,496 | | 117,515 | 155,011 |
| SUBTOTAL | | | | | 224,975 | | 705,092 | 930,067 |
| DESIGN @ 6% | | | | | | | | 55,804 |
| SUBTOTAL | | | | | | | | 985,871 |
| SIOH @ 5.5% | | | | | | | | 54,223 |
| TOTAL | | | | | | | | $1,040,094 |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-0185.6N2 | DATE: | 9/19/96 |
| ECO NO. N-2 Retrofit Existing Individual Chillers | BY : KOTHMANN, K | CHKD BY: | CARTER, J. |

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
AREA 2200

| ITEM DESCRIPTION SHEET 1 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 670 | TON | 1.5 | 28.91 | 29,829 | 25.00 | 16,750 | 46,579 |
| RMV CHILLER UP TO 50 TON | 100 | TON | 1.6 | 28.91 | 4,655 | 25.00 | 2,500 | 7,155 |
| REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED | 2 | EA | 1.5 | 22.00 | 66 | 50.00 | 100 | 166 |
| RMV DIRECT EXPANSION CONDENSER & AHU | 2 | EA | 5.0 | 28.91 | 289 | 50.00 | 100 | 389 |
| RMV COOLING TOWER | 675 | TON | 0.3 | 20.00 | 4,050 | 3.00 | 2,025 | 6,075 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 10" | 100 | LF | 1.8 | 28.91 | 5,204 | 56.50 | 5,650 | 10,854 |
| 4" | 10 | LF | 0.8 | 28.91 | 217 | 19.55 | 196 | 412 |
| 3" | 700 | LF | 0.6 | 28.91 | 12,142 | 15.70 | 10,990 | 23,132 |
| 2-1/2" | 400 | LF | 0.5 | 28.91 | 5,551 | 13.33 | 5,332 | 10,883 |
| | | | | SUBTOTAL | 62,002 | | 43,643 | 105,645 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. N-2** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6N2

**BY :** KOTHMANN, K

**DATE:** 9/19/96

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
AREA 2200

| ITEM DESCRIPTION SHEET 2 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| SECTIONALIZING VALVE AND BOX | 4 | EA | 2.1 | 28.91 | 241 | 590.00 | 2,360 | 2,601 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 200.0 | 20.00 | 4,000 | 3,000.00 | 3,000 | 7,000 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 3 | LOC | 10.7 | 28.91 | 924 | 717.00 | 2,151 | 3,075 |
| ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE, | | | | | | | | |
| PIPING ASSEMBLY & ELECTRICAL CONNECTION | | | | | | | | |
| AHU W/ CHW COIL 2-PIPE | 2 | EA | 54.0 | 28.91 | 3,122 | 6,400.00 | 12,800 | 15,922 |
| | | | | SUBTOTAL | 8,737 | | 21,346 | 30,083 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6N2

**DATE:** 9/19/96

**ECO NO. N-2** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
AREA 2200

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| EXPAND CENTRAL PLANT BASE BUILDING | 750 | BSF | | | | 75.00 | 56,250 | 56,250 |
| HISTORICALLY COMPATIBLE | | | | | | | | |
| COOLING TOWER ENCLOSURE | 1 | SUM | 1.0 | 9,000.00 | 9,000 | 12,000.00 | 12,000 | 21,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 750 | BSF | | | | 34.00 | 25,500 | 25,500 |
| CHILLER (YORK YT) WITH PIPING & VESELS | 815 | TON | 3.2 | 28.91 | 75,397 | 371.00 | 302,365 | 377,762 |
| ADD FOR VFD | 175 | HP | 0.8 | 28.91 | 4,047 | 150.00 | 26,250 | 30,297 |
| PRIMARY PUMPS 40 HP | 1 | EA | 60.0 | 28.91 | 1,735 | 7,500.00 | 7,500 | 9,235 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 815 | TON | 0.6 | 28.91 | 14,137 | 92.00 | 74,980 | 89,117 |
| 10" PIPING MANIFOLD AND VALVES | 1 | JOB | 170.0 | 28.91 | 4,915 | 5,700.00 | 5,700 | 10,615 |
| | | | | SUBTOTAL | 109,231 | | 510,545 | 619,776 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

PROJECT NO: 03-185.6N2

DATE: 9/19/96

ECO NO. N-2 Retrofit Existing Individual Chillers

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
AREA 2200

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND NEW CHW PUMPS COST PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 21.2 | 28.91 | 613 | 2,417.00 | 2,417 | 3,030 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 100 | EA | 0.5 | 28.91 | 1,446 | 7.05 | 705 | 2,151 |
| 1-1/2" | 50 | EA | 0.4 | 28.91 | 578 | 5.05 | 253 | 831 |
| 1" | 50 | EA | 0.3 | 28.91 | 434 | 4.38 | 219 | 653 |
| 3/4" | 100 | EA | 0.3 | 28.91 | | 2.75 | | |
| SUBTOTAL | | | | | 3,070 | | 3,594 | 6,664 |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| TOTAL | | | | | | | | |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. N-2** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6N2

**DATE:** 9/19/96

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** NEW Central Plant and HVAC Equipment WATER COOLED CENTRIFUGAL WITH VFD
AREA 2200

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, | 2 | EA | 4.8 | 28.91 | 275 | 1,375.00 | 2,750 | 3,025 |
| CONTROL VALVE AND ELECTRIC CIRCUIT | | | | | | | | |
| CHANGE 3-WAY CONTROL VALVES TO 2-WAY | 71 | EA | 4.0 | 28.91 | 8,210 | 450.00 | 31,950 | 40,160 |
| SUB TOTAL FROM SHEET 1 | | | | | 62,002 | | 43,643 | 105,645 |
| SUB TOTAL FROM SHEET 2 | | | | | 8,737 | | 21,346 | 30,083 |
| SUB TOTAL FROM SHEET 3 | | | | | 109,231 | | 510,545 | 619,776 |
| SUB TOTAL FROM SHEET 4 | | | | | 3,070 | | 3,594 | 6,664 |
| SUBTOTAL | | | | | 191,526 | | 613,827 | 805,353 |
| O & P @ 20% | | | | | 38,305 | | 122,765 | 161,071 |
| SUBTOTAL | | | | | 229,832 | | 736,592 | 966,424 |
| DESIGN @ 6% | | | | | | | | 57,985 |
| SUBTOTAL | | | | | | | | 1,024,409 |
| SIOH @ 5.5% | | | | | | | | 56,343 |
| TOTAL | | | | | | | | $1,080,752 |

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**ENGINEERS / ARCHITECTS**
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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-0185.6N3

**DATE:** 9/19/96

**ECO NO. N-3** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 670 | TON | 1.5 | 28.91 | 29,829 | 25.00 | 16,750 | 46,579 |
| RMV CHILLER UP TO 50 TON | 100 | TON | 1.6 | 28.91 | 4,655 | 25.00 | 2,500 | 7,155 |
| REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED | 2 | EA | 1.5 | 22.00 | 66 | 50.00 | 100 | 166 |
| RMV DIRECT EXPANSION CONDENSER & AHU | 2 | EA | 5.0 | 28.91 | 289 | 50.00 | 100 | 389 |
| RMV COOLING TOWER | 675 | TON | 0.3 | 20.00 | 4,050 | 3.00 | 2,025 | 6,075 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 10" | 100 | LF | 1.8 | 28.91 | 5,204 | 56.50 | 5,650 | 10,854 |
| 4" | 10 | LF | 0.8 | 28.91 | 217 | 19.55 | 196 | 412 |
| 3" | 700 | LF | 0.6 | 28.91 | 12,142 | 15.70 | 10,990 | 23,132 |
| 2-1/2" | 400 | LF | 0.5 | 28.91 | 5,551 | 13.33 | 5,332 | 10,883 |
| | | | | SUBTOTAL | 62,002 | | 43,643 | 105,645 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**ECO NO. N-3** Retrofit Existing Individual Chillers

**PROJECT NO:** 03-185.6N3 **DATE:** 9/19/96

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX | 4 | EA | 2.1 | 28.91 | 241 | 590.00 | 2,360 | 2,601 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 200.0 | 20.00 | 4,000 | 3,000.00 | 3,000 | 7,000 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 3 | LOC | 10.7 | 28.91 | 924 | 717.00 | 2,151 | 3,075 |
| ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE, | | | | | | | | |
| PIPING ASSEMBLY & ELECTRICAL CONNECTION | | | | | | | | |
| AHU W/ CHW COIL 2-PIPE | 2 | EA | 54.0 | 28.91 | 3,122 | 6,400.00 | 12,800 | 15,922 |
| | | | | SUBTOTAL | 8,737 | | 21,346 | 30,083 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6N3
**DATE:** 9/19/96

**ECO NO. N-3** Retrofit Existing Individual Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| EXPAND CENTRAL PLANT BASE BUILDING | 750 | BSF | | | | 75.00 | 56,250 | 56,250 |
| HISTORICALLY COMPATIBLE | | | | | | | | |
| COOLING TOWER ENCLOSURE | 1 | SUM | 1.0 | 9,000.00 | 9,000 | 12,000.00 | 12,000 | 21,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 750 | BSF | | | | 34.00 | 25,500 | 25,500 |
| CHILLER (YORK YS) WITH PIPING & VESELS | 815 | TON | 3.2 | 28.91 | 75,397 | 416.00 | 339,040 | 414,437 |
| PRIMARY PUMPS 40 HP | 1 | EA | 60.0 | 28.91 | 1,735 | 7,500.00 | 7,500 | 9,235 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 815 | TON | 0.6 | 28.91 | 14,137 | 92.00 | 74,980 | 89,117 |
| 10" PIPING MANIFOLD AND VALVES | 1 | JOB | 170.0 | 28.91 | 4,915 | 5,700.00 | 5,700 | 10,615 |
| | | | | SUBTOTAL | 105,184 | | 520,970 | 626,154 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-185.6N3

**DATE:** 9/19/96

**ECO NO. N-3** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K

**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND NEW CHW PUMPS COST PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 21.2 | 28.91 | 613 | 2,417.00 | 2,417 | 3,030 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 100 | EA | 0.5 | 28.91 | 1,446 | 7.05 | 705 | 2,151 |
| 1-1/2" | 50 | EA | 0.4 | 28.91 | 578 | 5.05 | 253 | 831 |
| 1" | 50 | EA | 0.3 | 28.91 | 434 | 4.38 | 219 | 653 |
| 3/4" | 100 | EA | 0.3 | 28.91 | | 2.75 | | |
| | | | | SUBTOTAL | 3,070 | | 3,594 | 6,664 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. N-3 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6N3

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: NEW Central Plant and HVAC Equipment WATER COOLED SCREW
AREA 2200

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, | 2 | EA | 4.8 | 28.91 | 275 | 1,375.00 | 2,750 | 3,025 |
| CONTROL VALVE AND ELECTRIC CIRCUIT | | | | | | | | |
| CHANGE 3-WAY CONTROL VALVES TO 2-WAY | 71 | EA | 4.0 | 28.91 | 8,210 | 450.00 | 31,950 | 40,160 |
| SUB TOTAL FROM SHEET 1 | | | | | 62,002 | | 43,643 | 105,645 |
| SUB TOTAL FROM SHEET 2 | | | | | 8,737 | | 21,346 | 30,083 |
| SUB TOTAL FROM SHEET 3 | | | | | 105,184 | | 520,970 | 626,154 |
| SUB TOTAL FROM SHEET 4 | | | | | 3,070 | | 3,594 | 6,664 |
| SUBTOTAL | | | | | 187,479 | | 624,252 | 811,731 |
| O & P @ 20% | | | | | 37,496 | | 124,850 | 162,346 |
| SUBTOTAL | | | | | 224,975 | | 749,102 | 974,077 |
| DESIGN @ 6% | | | | | | | | 58,445 |
| SUBTOTAL | | | | | | | | 1,032,522 |
| SIOH @ 5.5% | | | | | | | | 56,789 |
| TOTAL | | | | | | | | $1,089,310 |


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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX

**PROJECT NO:** 03-0185.6N4 **DATE:** 9/19/96

**ECO NO. N-4** Retrofit Existing Individual Chillers

**BY :** KOTHMANN, K **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
AREA 2200

| ITEM DESCRIPTION SHEET 1 | QUANTITY # of Units | QUANTITY Unit Meas. | LABOR Hrs / Unit | LABOR Rate | LABOR Total | MATERIAL Unit Price | MATERIAL Total | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| REMOVE THE FOLLOWING EQUIPMENT | | | | | | | | |
| INCLUDEING ELECTRICAL AND ASSOCIATED PIPING | | | | | | | | |
| RMV CHILLER | 670 | TON | 1.5 | 28.91 | 29,829 | 25.00 | 16,750 | 46,579 |
| RMV CHILLER UP TO 50 TON | 100 | TON | 1.6 | 28.91 | 4,655 | 25.00 | 2,500 | 7,155 |
| REMOVE WINDOW UNIT & REPAIR WINDOW AS REQUIRED | 2 | EA | 1.5 | 22.00 | 66 | 50.00 | 100 | 166 |
| RMV DIRECT EXPANSION CONDENSER & AHU | 2 | EA | 5.0 | 28.91 | 289 | 50.00 | 100 | 389 |
| RMV COOLING TOWER | 675 | TON | 0.3 | 20.00 | 4,050 | 3.00 | 2,025 | 6,075 |
| (NO DISCOUNT FOR SALVAGE) | | | | | | | | |
| PRE INSULATED CONDUIT SCH 40 CARRIER PVC JACKET | | | | | | | | |
| DIRECT BURY WITH TRENCH AND BACKFILL | | | | | | | | |
| 10" | 100 | LF | 1.8 | 28.91 | 5,204 | 56.50 | 5,650 | 10,854 |
| 4" | 10 | LF | 0.8 | 28.91 | 217 | 19.55 | 196 | 412 |
| 3" | 700 | LF | 0.6 | 28.91 | 12,142 | 15.70 | 10,990 | 23,132 |
| 2-1/2" | 400 | LF | 0.5 | 28.91 | 5,551 | 13.33 | 5,332 | 10,883 |
| | | | | SUBTOTAL | 62,002 | | 43,643 | 105,645 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX | PROJECT NO: 03-185.6N4 | DATE: 9/19/96 |
| ECO NO. N-4 | BY : KOTHMANN, K | CHKD BY: CARTER, J. |

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN AREA 2200

| ITEM DESCRIPTION SHEET 2 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SECTIONALIZING VALVE AND BOX | 4 | EA | 2.1 | 28.91 | 241 | 590.00 | 2,360 | 2,601 |
| | | | | 28.91 | | | | |
| REPAIR HARDSCAPE AND LANDSCAPE | 1 | JOB | 200.0 | 20.00 | 4,000 | 3,000.00 | 3,000 | 7,000 |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND CONNECT TO EXISTING CHW PUMPS PER LOCATION | | | | | | | | |
| 4" | 1 | LOC | 15.6 | 28.91 | 451 | 1,035.00 | 1,035 | 1,486 |
| 3" | 3 | LOC | 10.7 | 28.91 | 924 | 717.00 | 2,151 | 3,075 |
| ALL AIR SIDE EQUIPMENT INCLUDES CONTROL VALVE, | | | | | | | | |
| PIPING ASSEMBLY & ELECTRICAL CONNECTION | | | | | | | | |
| AHU W/ CHW COIL 2-PIPE | 2 | EA | 54.0 | 28.91 | 3,122 | 6,400.00 | 12,800 | 15,922 |
| | | | | SUBTOTAL | 8,737 | | 21,346 | 30,083 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX | **PROJECT NO:** 03-185.6N4 | **DATE:** 9/19/96

**ECO NO. N-4** Retrofit Existing Individual Chillers | **BY :** KOTHMANN, K | **CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN AREA 2200

| ITEM DESCRIPTION SHEET 3 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| EXPAND CENTRAL PLANT BASE BUILDING | 750 | BSF | | | | 75.00 | 56,250 | 56,250 |
| HISTORICALLY COMPATIBLE | | | | | | | | |
| COOLING TOWER ENCLOSURE | 1 | SUM | 1.0 | 9,000.00 | 9,000 | 12,000.00 | 12,000 | 21,000 |
| CENTRAL PLANT ELECTRICAL SYSTEM | 750 | BSF | | | | 34.00 | 25,500 | 25,500 |
| CHILLER (YORK YG) WITH PIPING & VESELS | 815 | TON | 4.5 | 28.91 | 106,027 | 896.00 | 730,240 | 836,267 |
| PRIMARY PUMPS 60 HP | 1 | EA | 110.0 | 28.91 | 3,180 | 8,900.00 | 8,900 | 12,080 |
| COOLING TOWER W/ CNDSR PIPE LOOP AND PUMPS | 815 | TON | 0.6 | 28.91 | 14,137 | 92.00 | 74,980 | 89,117 |
| 10" PIPING MANIFOLD AND VALVES | 1 | JOB | 170.0 | 28.91 | 4,915 | 5,700.00 | 5,700 | 10,615 |
| | | | | SUBTOTAL | 137,259 | | 913,570 | 1,050,829 |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | TOTAL | | | | |


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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: FORT SAM HOUSTON , SAN ANTONIO, TEX

ECO NO. N-4 Retrofit Existing Individual Chillers

PROJECT NO: 03-185.6N4

DATE: 9/19/96

BY : KOTHMANN, K

CHKD BY: CARTER, J.

PROJECT DESCRIPTION: Install NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN AREA 2200

| ITEM DESCRIPTION SHEET 4 | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| SERVICE VALVES , CHW ENTRY PIPING ASSEMBLY | | | | | | | | |
| AND NEW CHW PUMPS COST PER LOCATION | | | | | | | | |
| 3" | 1 | LOC | 21.2 | 28.91 | 613 | 2,417.00 | 2,417 | 3,030 |
| INTERIOR BUILDING PIPING W/ INSULATION | | | | | | | | |
| SCH 40 BLK T&C W/ FITTINGS & HANGERS | | | | | | | | |
| 2" | 100 | EA | 0.5 | 28.91 | 1,446 | 7.05 | 705 | 2,151 |
| 1-1/2" | 50 | EA | 0.4 | 28.91 | 578 | 5.05 | 253 | 831 |
| 1" | 50 | EA | 0.3 | 28.91 | 434 | 4.38 | 219 | 653 |
| 3/4" | 100 | EA | 0.3 | 28.91 | | 2.75 | | |
| SUBTOTAL | | | | | 3,070 | | 3,594 | 6,664 |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| TOTAL | | | | | | | | |

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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** FORT SAM HOUSTON , SAN ANTONIO, TEX
**PROJECT NO:** 03-185.6N4
**DATE:** 9/19/96

**ECO NO. N-4** Retrofit Existing Individual Chillers
**BY :** KOTHMANN, K
**CHKD BY:** CARTER, J.

**PROJECT DESCRIPTION:** NEW Central Plant and HVAC Equipment WATER COOLED GAS ENGINE DRIVEN
AREA 2200

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| FAN COIL UNIT COMPLETE W/ PIPING ASSEMBLY, | 2 | EA | 4.8 | 28.91 | 275 | 1,375.00 | 2,750 | 3,025 |
| CONTROL VALVE AND ELECTRIC CIRCUIT | | | | | | | | |
| CHANGE 3-WAY CONTROL VALVES TO 2-WAY | 71 | EA | 4.0 | 28.91 | 8,210 | 450.00 | 31,950 | 40,160 |
| SUB TOTAL FROM SHEET 1 | | | | | 62,002 | | 43,643 | 105,645 |
| SUB TOTAL FROM SHEET 2 | | | | | 8,737 | | 21,346 | 30,083 |
| SUB TOTAL FROM SHEET 3 | | | | | 137,259 | | 913,570 | 1,050,829 |
| SUB TOTAL FROM SHEET 4 | | | | | 3,070 | | 3,594 | 6,664 |
| SUBTOTAL | | | | | 219,555 | | 1,016,852 | 1,236,407 |
| O & P @ 20% | | | | | 43,911 | | 203,370 | 247,281 |
| SUBTOTAL | | | | | 263,465 | | 1,220,222 | 1,483,688 |
| DESIGN @ 6% | | | | | | | | 89,021 |
| SUBTOTAL | | | | | | | | 1,572,709 |
| SIOH @ 5.5% | | | | | | | | 86,499 |
| TOTAL | | | | | | | | $1,659,208 |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis — Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-N1
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: JOHN CARTER

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $930,067 |
| B. SIOH | $54,223 |
| C. Design Cost | $55,804 |
| D. Total Cost (1A+1B+1C) | $1,040,094 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $1,040,094 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 3,050 | Mbtus | $19,154 | 15.08 | $288,842 |
| Elec. Deman | | | | | $25,570 | 14.88 | $380,482 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 3,050 | Mbtus | $44,724 | | $669,324 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $8,005 | Annual | 14.88 | $119,114 |
| ANNUAL TOTAL | $8,005 | | | $119,114 |
| REFRIGERANT RECLA | $2,628 | 0 | 1.0 | $2,628 |
| CHILLER RETROFIT | $45,000 | 0 | 1.0 | $45,000 |
| ONE TIME TOTAL | $47,628 | | | $47,628 |
| TOTAL | $55,633 | | | $166,742 |

| | |
|---|---|
| 4. First Year Dollar Savings | $55,110 |
| 5. Simple Payback Period (Years) | 18.87 |
| 6. Total Net Discounted Savings | $836,066 |
| 7. Savings to Investment Ratio | .8 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 1.88% |

Life Cycle Cost Analysis — Study: FSH-3.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: FORT SAM HOUSTON

Region data: TEXAS Census Region: 3

Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY

Fiscal Year: 1996 Discrete Portion: ECO-N2

Analysis Date: 09/20/96 Economic Life: 20 years

Prepared by: JOHN CARTER

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | 966424 |
| B. SIOH | 56343 |
| C. Design Cost | 57985 |
| D. Total Cost (1A+1B+1C) | $1,080,752 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | 0 |
| G. Total Investment (1D-1E-1F) | $1,080,752 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 3,370 | Mbtus | $21,164 | 15.08 | $319,147 |
| Elec. Deman | | | | | $25,345 | 14.88 | $377,134 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 3,370 | Mbtus | $46,509 | | $696,281 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $8,005 | Annual | 14.88 | $119,114 |
| ANNUAL TOTAL | $8,005 | | | $119,114 |
| REFRIGERANT RECLA | $2,628 | 0 | 1.0 | $2,628 |
| CHILLER RETROFIT | $45,000 | 0 | 1.0 | $45,000 |
| ONE TIME TOTAL | $47,628 | | | $47,628 |
| TOTAL | $55,633 | | | $166,742 |

| | |
|---|---|
| 4. First Year Dollar Savings | $56,895 |
| 5. Simple Payback Period (Years) | 19.0 |
| 6. Total Net Discounted Savings | $863,023 |
| 7. Savings to Investment Ratio | .8 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 1.85% |

Life Cycle Cost Analysis — Study: FSH-3.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: FORT SAM HOUSTON

Region data: TEXAS Census Region: 3

Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY

Fiscal Year: 1996 Discrete Portion: ECO-N3

Analysis Date: 09/20/96 Economic Life: 20 years

Prepared by: MIKE ELLIOTT

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $974,077 |
| B. SIOH | $56,789 |
| C. Design Cost | $58,445 |
| D. Total Cost (1A+1B+1C) | $1,089,311 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $1,089,311 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 2,842 | Mbtus | $17,848 | 15.08 | $269,144 |
| Elec. Deman | | | | | $22,010 | 14.88 | $327,509 |
| Natural Gas | $3.5 | /Mbtus | 0 | Mbtus | $0 | 18.58 | $0 |
| TOTAL | | | 2,842 | Mbtus | $39,858 | | $596,653 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $8,005 | Annual | 14.88 | $119,114 |
| ANNUAL TOTAL | $8,005 | | | $119,114 |
| REFRIGERANT RECLA | $2,628 | 0 | 1.0 | $2,628 |
| CHILLER RETROFIT | $45,000 | 0 | 1.0 | $45,000 |
| ONE TIME TOTAL | $47,628 | | | $47,628 |
| TOTAL | $55,633 | | | $166,742 |

| | |
|---|---|
| 4. First Year Dollar Savings | $50,244 |
| 5. Simple Payback Period (Years) | 21.68 |
| 6. Total Net Discounted Savings | $763,395 |
| 7. Savings to Investment Ratio | .7 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 1.19% |

Life Cycle Cost Analysis Study: FSH-3.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: FORT SAM HOUSTON
Region data: TEXAS Census Region: 3
Project NO. & Title: 03-0185.06 EEAP BOILER / CHILLER STUDY
Fiscal Year: 1996 Discrete Portion: ECO-N4
Analysis Date: 09/20/96 Economic Life: 20 years
Prepared by: JOHN CARTER

ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $1,483,688 |
| B. SIOH | $86,499 |
| C. Design Cost | $89,021 |
| D. Total Cost (1A+1B+1C) | $1,659,208 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $1,659,208 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1994

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $6.3 | /Mbtus | 4,826 | Mbtus | $30,307 | 15.08 | $457,034 |
| Elec. Deman | | | | | $49,038 | 14.88 | $729,685 |
| Natural Gas | $3.5 | /Mbtus | -8,229 | Mbtus | -$28,472 | 18.58 | -$529,016 |
| TOTAL | | | -3,403 | Mbtus | $50,873 | | $657,703 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL RECURRING | $8,005 | Annual | 14.88 | $119,114 |
| ANNUAL TOTAL | $8,005 | | | $119,114 |
| REFRIGERANT RECLA | $2,628 | 0 | 1.0 | $2,628 |
| CHILLER RETROFIT | $45,000 | 0 | 1.0 | $45,000 |
| ONE TIME TOTAL | $47,628 | | | $47,628 |
| TOTAL | $55,633 | | | $166,742 |

| | |
|---|---|
| 4. First Year Dollar Savings | $61,259 |
| 5. Simple Payback Period (Years) | 27.08 |
| 6. Total Net Discounted Savings | $824,446 |
| 7. Savings to Investment Ratio | .5 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | -.54% |

# APPENDIX D
# SCOPE OF WORK AND REVIEW COMMENTS

## TABLE OF CONTENTS

DETAILED SCOPE OF WORK
CONTRACT NO. DACAC63-94-D-0015
DELIVERY ORDER NO. 0008

1. The Architect-Engineer (A-E) shall furnish all services, material, supplies, plant, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified project for design in accordance with the original basic contract and this Detailed Scope of Work. Appendis "A" of the basic contract shall be followed for performance requirements for A-E services. Where this Detailed Scope of Work conflicts with Appendix "A", this Detailed Scope of Work shall govern.

| INSTALLATION | PROJECT TITLE |
|---|---|
| Fort Sam Houston, TX | Boiler/Chiller Study (EEAP) |

2. The work and other related data and sevices required in this Delivery Order shall be accomplished within the time schedule required, in accordance with the subject stated above and scope of work described in paragraph 3 below. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

| | | DELIVERY SCHEDULE |
|---|---|---|
| a. | Interim Submittal and related data for studies (See Annex B for number of copies) | 120 calendar days after receipt of Delivery Order |
| b. | Pre-Final Submittal(s) (95% Submittal) | 60 calendar days after approval of Interim submittal |
| c. | Final Submittal (original and all data developed under this submittal) | 60 calendar days after approval of the pre-final |

3. The items of work included in this Delivery Order shall be in accordance with criteria furnished at the Scoping conference held 19 April 1995 at Fort Sam Houston. The services to be provided shall include, but not be limited to, the following Scope of Work.

a. Items of Work:

1. <u>BRIEF DESCRIPTION OF WORK</u>: The Architect-Engineer (AE) shall:

1.2 Perform a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOs included in this study.

1.4 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.5 Provide project documentation for recommended ECOs as detailed herein.

1.6 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. <u>GENERAL</u>

2.1 This study is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3. For the buildings, systems or ECOs listed in Annex A, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 Jan 1994 (including current updates) establishes criteria for ECIP projects and shall be used for performing the economic analyses of <u>all</u> ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified

in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Computer modeling will be used to determine the energy savings of ECOs which would replace or significantly change an existing heating, ventilating, and air-conditioning (HVAC) system. The requirement to use computer modeling applies only to heated and air-conditioned or air-conditioned-only buildings which exceed 8,000 square feet or heated-only buildings in excess of 20,000 square feet. Modeling will be done using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting and other energy-producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads of the building under study. The program will use established weather data files and may perform calculations on a true, hour-by-hour basis or may condense the weather files and the number of calculations into several "typical" days per month. The Detailed Scope of Work, Annex A, will list programs that are acceptable to the Contracting Officer. If the AE desires to use a different program, it must be submitted for approval with a sample run, an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities.

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP or FEMP funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR)

2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.7.3 At some installations Energy Conservation and Management (ECAM) funding will be used instead of ECIP funding. The criteria for each program is the same. The Director of Public Works will indicate which program is used at this installation. This Scope of Work mentions only ECIP, however, ECAM is also meant.

2.8 Metric Reporting Requirements: In this study, the analyses of the ECOs may be performed using English or Metric units as long as they are consistent throughout the report. The final results of energy savings for individual recommended projects and for the overall study will be reported in units of MegaBTU per year <u>and</u> in MegaWatts per year. Paragraph 7.6.2 details requirements for the contents of the final submittal.

## 3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, will be in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this

contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Public Works before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the Director of Public Works.

3.7.2 Exit. The exit interview shall be held when the field work is essentially complete; it shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Public Works.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), labor, supervision, and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio (SIR) greater than 1.25 and a simple payback period of less than ten years. The overall project and each discrete part of the project shall have an SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.7.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391 and life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account

the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.7.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA (energy savings calculations and cost estimate), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. Federal Energy Management Program (FEMP) Projects. A FEMP (or O&M Energy) project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, ie, SIR $\geq$ 1.25, and simple payback period of less than ten years. Projects with a construction cost estimate up to $1,000,000 shall be documented as outlined in par 5.2 above; projects over $1,000,000 shall be documented on 1391s. In the FEMP program, a system may be defined as "failed or failing" if it is inefficient or technically obsolete. However, if this strategy is used to justify a proposed project, the equipment to be replaced must have been in use for at least three years.

b. Low Cost/No Cost Projects. These are projects which the Director of Public Works (DPW) can perform using his resources. Documentation shall be as required by the DPW.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

## 7. WORK TO BE ACCOMPLISHED.

7.3 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or on standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.4 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.5 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph [7.6.1], the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par [7.6.2].

7.6 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections,

subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the Director of Public Works, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.6.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. These lists may be subdivided by building or area as appropriate for the study.

The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Director of Public Works to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.6.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph [7.6.1] shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

ANNEX A

DETAILED SCOPE OF WORK

BOILER/CHILLER STUDY

FORT SAM HOUSTON, TX

1. The General Scope of Work outlines the requirements for the study and the report; and the detailed scope of work describes the specific areas to be studied. If any conflicts arise between the General and the Detailed scopes of work, the Detailed Scope of Work shall govern.

2. A study shall be conducted in five operational areas within Fort Sam Houston. These areas are generally described as 100, 500, 1000, 1300, and 2200 Areas; each including several major and secondary buildings. The study shall focus on establishing the feasibility of modifying or constructing centralized heating and cooling plants to serve each of the five areas. Each of the areas designated, other than the 100 Area, has existing central facilities in place. Each of the areas designated, other than the 500 and 1000 Areas, has been the subject of recent investigation and analysis in a prior boiler/chiller study. This study seeks to expand the recommendations developed in the previous study for areas 100, 1300, and 2200 to include additional existing buildings within those areas which were excluded from the scope of work in the prior study. All recommendations will be reevaluated based on the expanded load profile generated by the increased area served. A study of the specified buildings in Areas 500 and 1000 will be conducted to establish recommendations for centralized heating and cooling facilities in those areas.

3. The work consists of evaluating buildings listed below for each functional area and modeling each building to develop a probable annual thermal load profile. Fort Sam Houston will furnish as-built drawings on the buildings and the Consultant will perform a survey of the buildings to collect information necessary to more accurately develop the annual thermal profile of each. The Consultant will evaluate the feasibility and economic impacts of modifying the existing cooling and heating plants in the areas served. The feasibility study will consider chiller replacement or retrofit and boiler upgrade or replacement. A limited survey of the existing buildings served by each plant will be performed to permit a qualitative verification that the existing plant capacities are adequate. The survey will also reveal constraining requirements such as year-round cooling requirements which may influence the recommendations. Chiller replacement/retrofit recommendations will consider refrigerants 123 or 134a only, gas vs. electrical driven compressors, drive configuration (i.e. open-drive vs. hermetic), operating efficiency (i.e. compressor type: screw vs. centrifugal part load and full load capacities and variable speed drive) and maintainability. The cost effects of the new design criteria from the Uniform Mechanical code which requires a partition be provided between the chiller and boiler shall be investigated. The efficacy of installing DDC control systems for each of the five functionaa areas will be evaluated. Recommendations will be supported by life cycle cost analyses which will include initial purchase and installation costs, energy consumption costs, and maintenance costs extended over the useful life of the equipment.

4. The following buildings will be evaluated during this study:

a. 123, 126, 129, 131, 140, 141, 151, 152, 154, 155, 156, 157, 158, 159, 260, 261, 268; and previously studied buildings 122, 124, 125, 127, 128, 133, 134, 135, 142, 143, 144, 145, 146, 147, 149, 197, 198, 199, and 250.

b. 590, 591, and 592.

c. 1000, 1001, 1029, and 1088.

d. 1384, 1387, 1396, 1398; and previously studied buildings 1350, 1374, 1375, 1377, 1379, 1380, 1382, and 1385.

e. 2200, 2244, 2247, 2248, 2250, 2270, 2272, 2273, 2288; and previously studied buildings 2263, 2264, 2265, and 2266.

5. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The final report for this study shall be due not later Notice to Proceed.

| MILESTONE | PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT |
|---|---|
| Completion of Field Work | 25 |
| Receipt of Interim Submittal | 75 |
| Completion of Interim Presentation & Review | 85 |
| Receipt of Pre-Final Submittal | 95 |
| Receipt of Final Report | 100 |

6. Thermal modeling will be accomplished using the Trane Air-Conditioning Economics (TRACE) computer program. Economic analysis will be accomplished using the computer program Life Cycle Costing in Design (LCCID).

7. The following documents will be furnished to the Consultant by the Government:

a. As-built drawings of the buildings specified above.

b. Energy consumption records.

c. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

d. ETL 1110-3-254, Use of Electric Power for Comfort Space Heating

e. ETL 1110-3-282, Energy Conservation

f. TM 5-785, Engineering Weather Data

g. TM 5-800-2, Cost Estimates, Military Construction

h. AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

i. Architectural and Engineering Instructions, Design Criteria, 18 September 1992

j. The latest MCP Index.

8. Reports and correspondence shall be provided as follows:

| | |
|---|---|
| Commander<br>ATTN: AFZG-PW-ESB/Mr. Frank Carbonel<br>Department of the Army<br>HQ, Fort Sam Houston<br>Fort Sam Houston, TX 78234 | 2 copies each report<br>1 copy of field notes<br>1 copy of correspondence |
| Commander<br>U.S. Army Engineer District, Fort Worth<br>ATTN: CESWF-ED-MP/Mr. Richard Champagne<br>819 Taylor Street/P.O. Box 17300<br>Fort Worth, TX 76102-0300 | 2 copies each report<br>1 copy of field notes<br>1 copy of correspondence |
| Commander<br>U.S. Army Engineer District, Fort Worth<br>ATTN: CESAM-EN-DM/Mr. Tony Battaglia<br>P.O. Box 2288<br>Mobile, AL 36628-0001 | 1 copy each report<br>1 copy of correspondence |

## ANNEX B

## EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   o Total Annual Energy Used.

   o Source Energy Consumption.

   Electricity - KWH, Dollars, BTU
   Fuel Oil - GALS, Dollars, BTU, MWH
   Natural Gas - THERMS, Dollars, BTU, MWH
   Propane - GALS, Dollars, BTU, MWH
   Other - QTY, Dollars, BTU, MWH

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP Projects Developed. (Provide list)*

   o Non-ECIP Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

   * Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX C

REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor ajects.

(11) Latest MCP Index, essential for projecting costs for project documentation.

(12) The following items are important and should be provided to the AE to the extent to which they are available:

(a) As-built drawings of applicable buildings, equipment, or systems

(b) Handbooks or SOPs relating to the operation of applicable equipment or systems.

(c) Applicable records of energy or fuel usage.

(d) Copies of bills for electrical enetration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Claims for boiler efficiency improvements must identify data to support present properly adjusted boiler operation and future expected efficiency. If full replacement of boilers is indicated, explain rejection of alternatives such as replace burners, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit actions.

f. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

g. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

h. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period.

i. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

j. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit, (2) the specific retrofit action applicable and (3) an economic analysis supporting the specific retrofit.

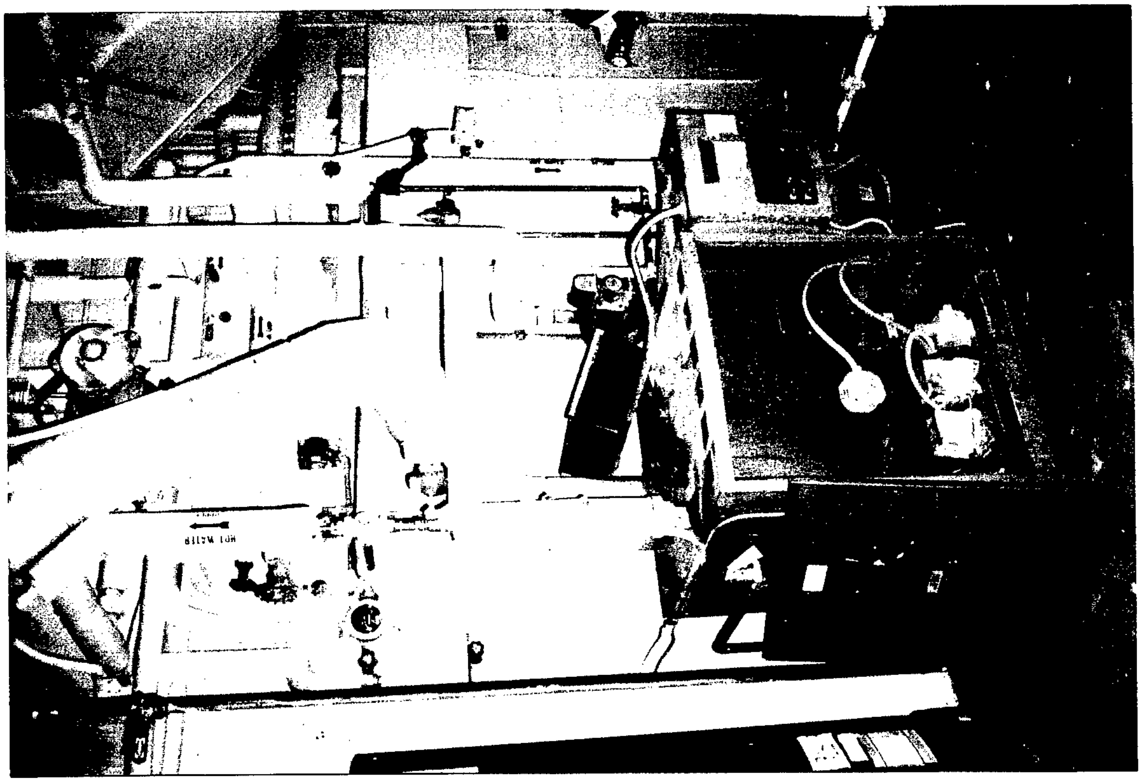
k. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

l. Any requirements required by ECIP guidance dated 10 Jan 1994 and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

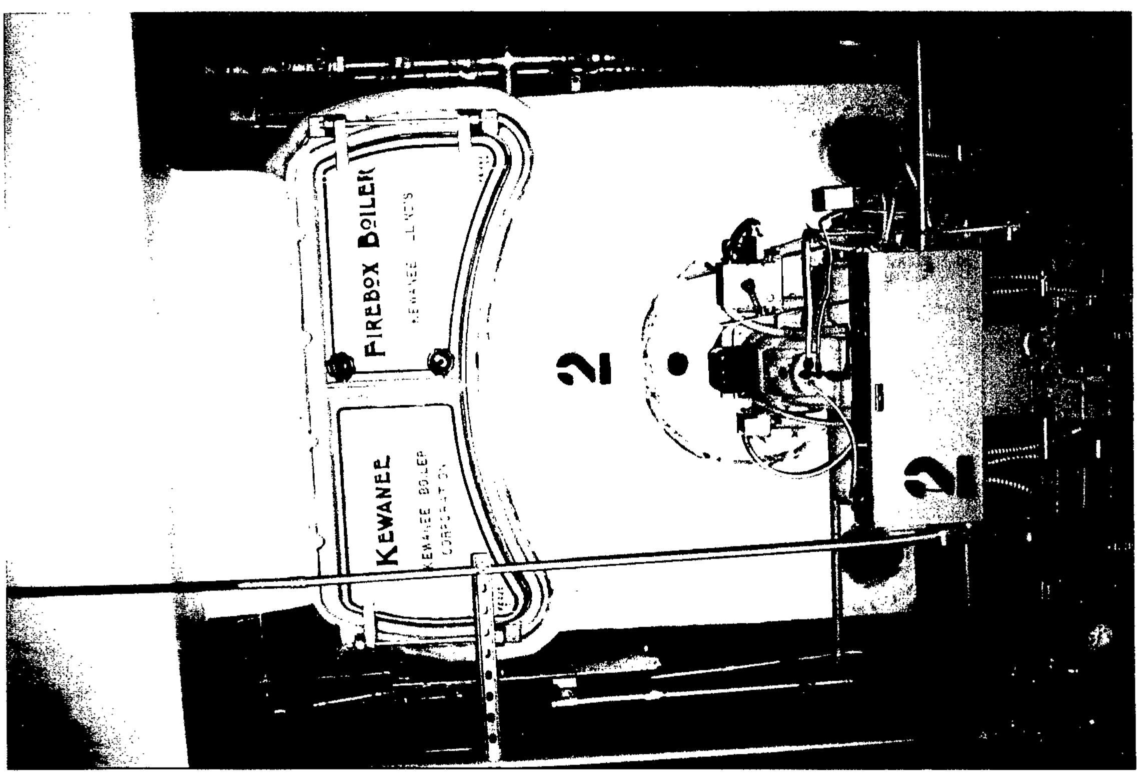
m. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

# APPENDIX E
# PHOTOGRAPHS

## TABLE OF CONTENTS



HW boiler serving building 268. Three (3) way actuator has been removed.



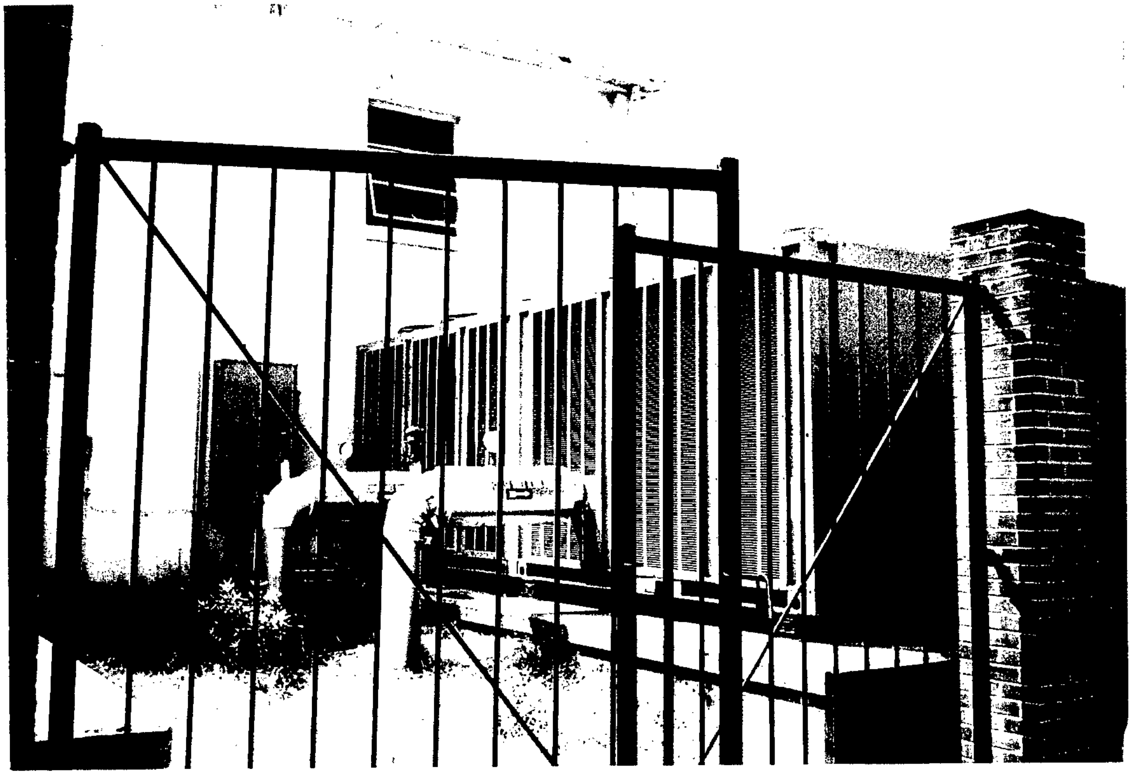

Steam boiler serving building 250, typical of two(2).

Air cooled chiller serving building 268. Notice bushes at inlet of condenser.

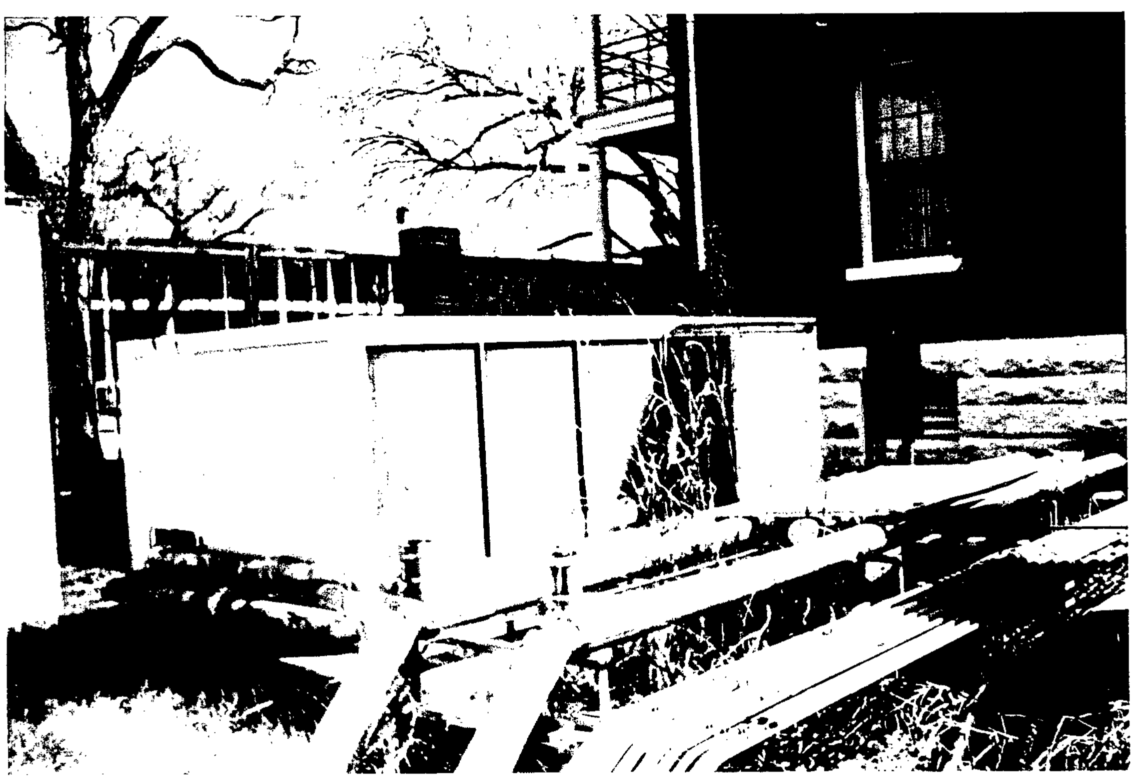
Additional chiller pad (21'-5" x 10'-8") for additional chiller (if needed).

Building 250 existing central boiler plant and air cooled chiller yard.

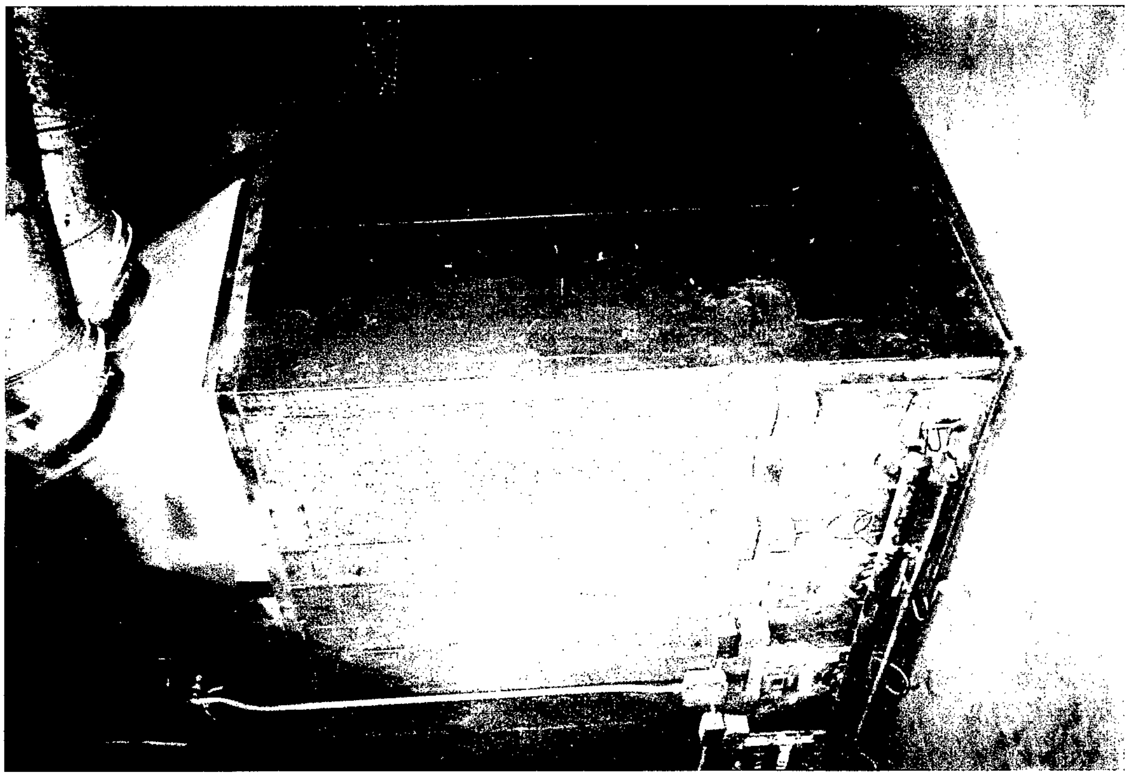
Proposed location for Area 100 central plant addition.



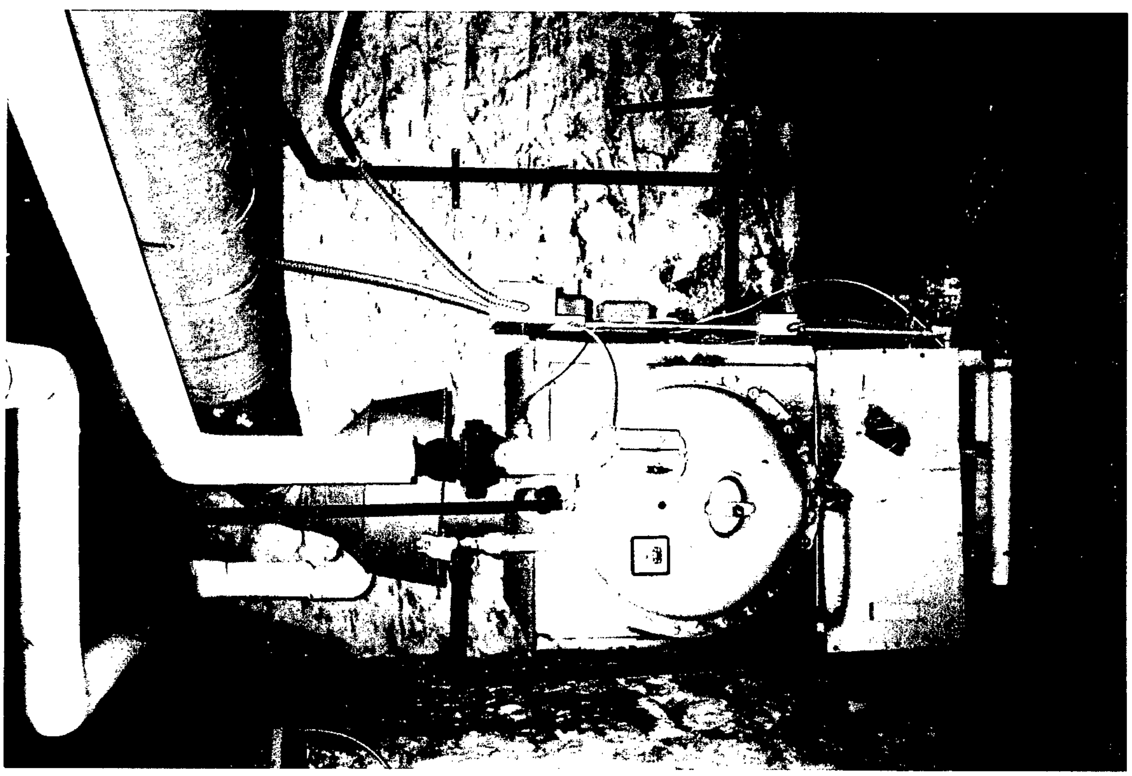
Air cooled chiller serving building 250.



Air cooled chiller serving buildings 147 & 149.



Warn air furnace serving building 145 located in the basement.

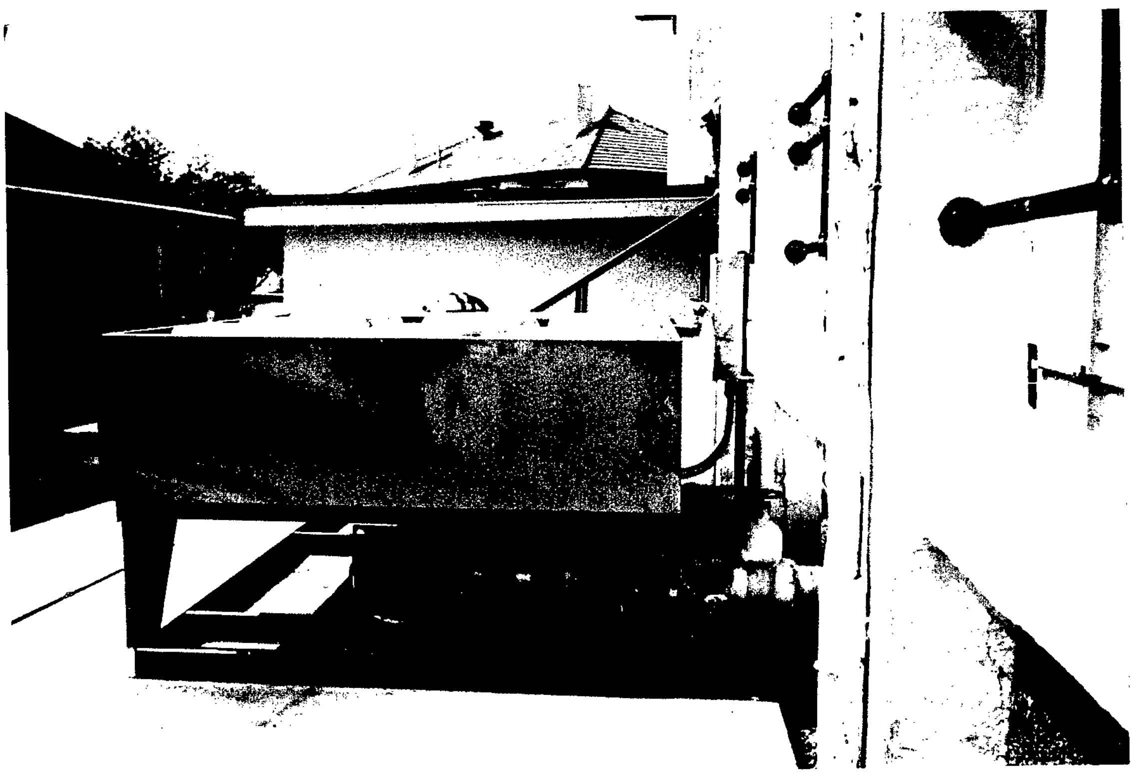


HW boiler serving building 149 located in the basement.

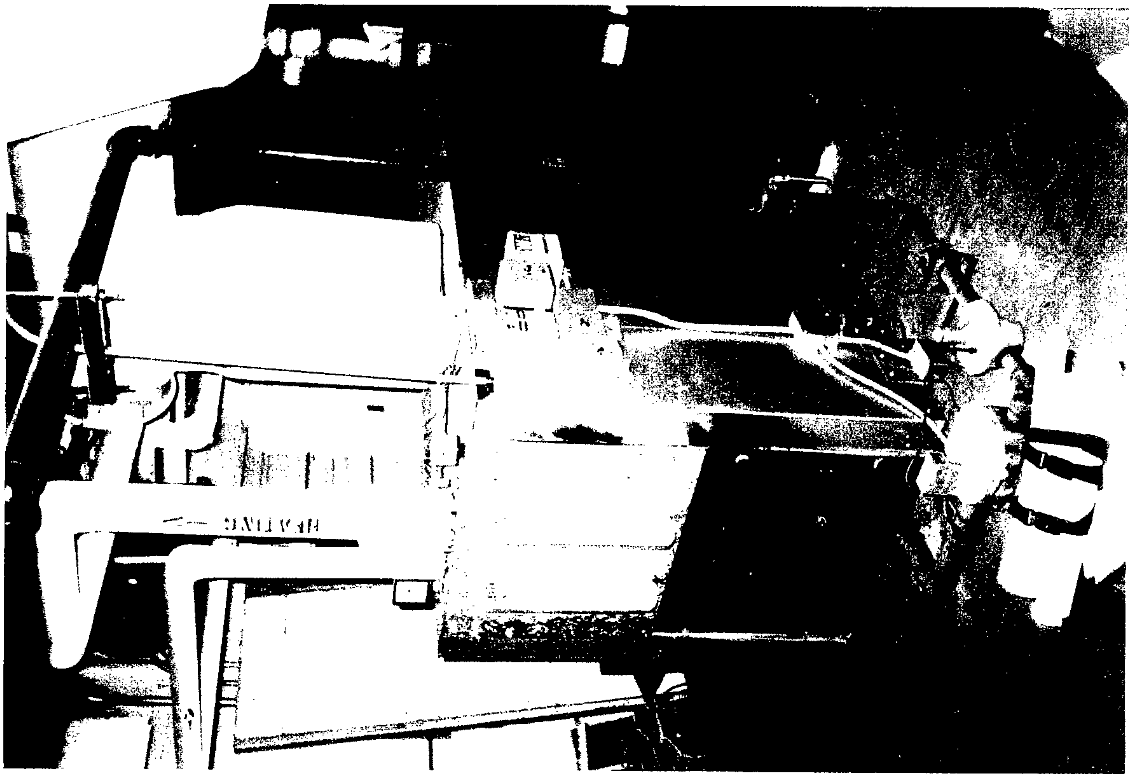
Window units serving building 145.


HW boiler and DHW heater serving building 144.

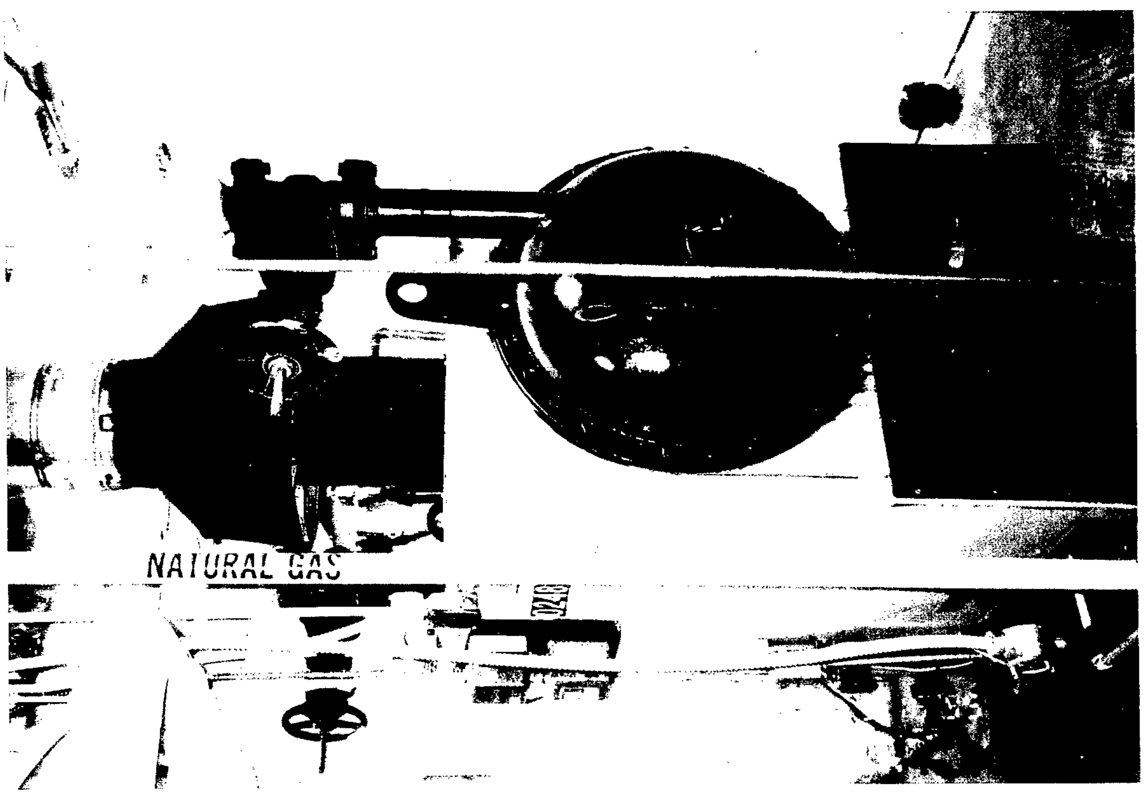
Air cooled chiller serving building 142.



Air cooled chiller serving building 197.

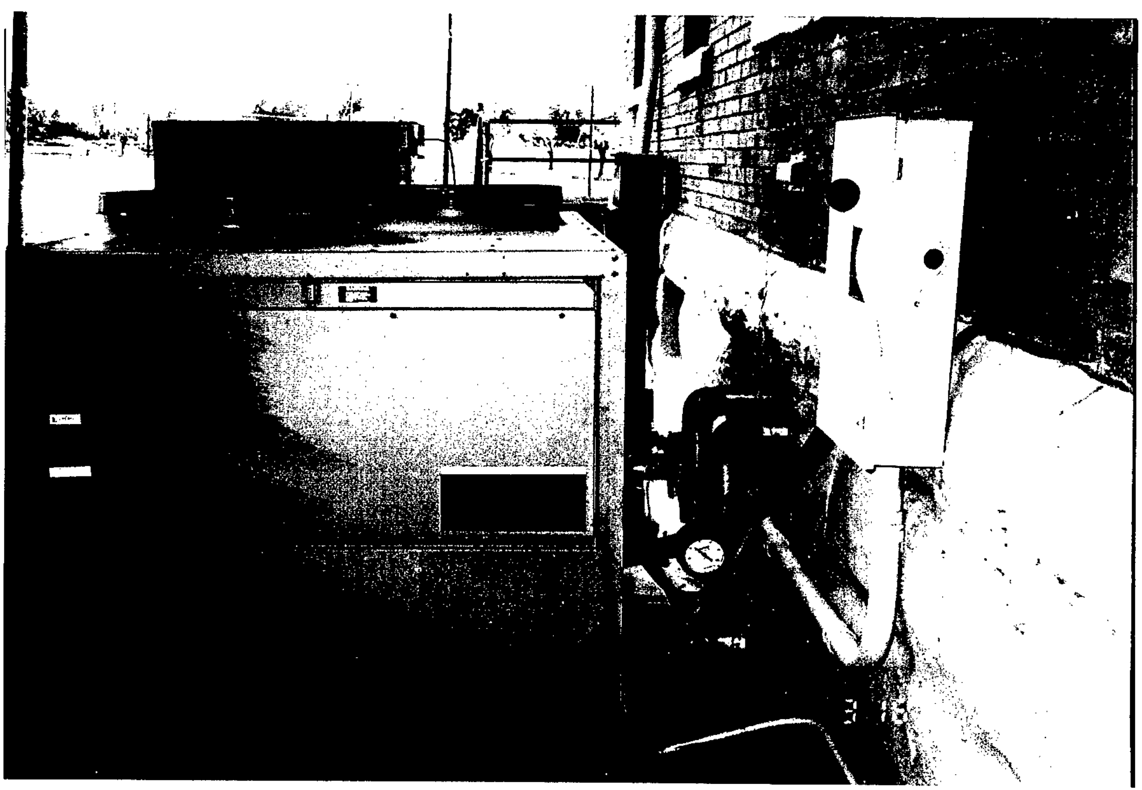


HW boiler serving building 197

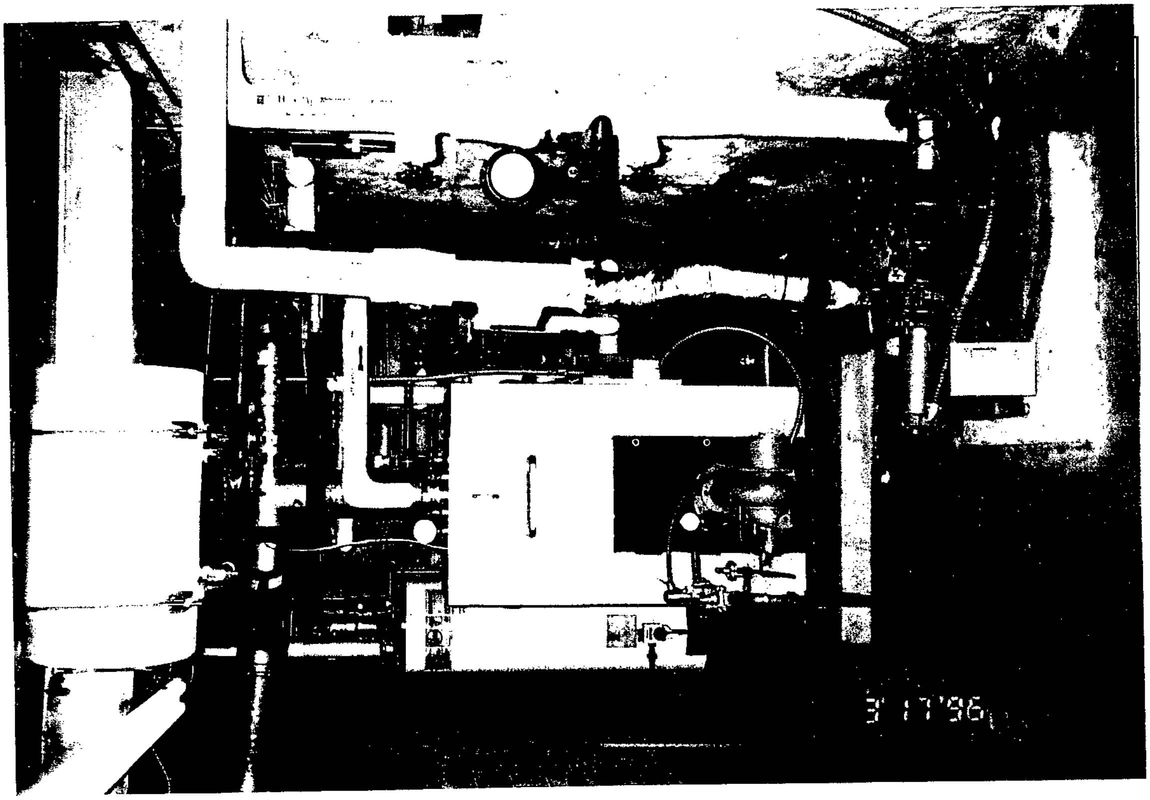



HW boiler serving building 134

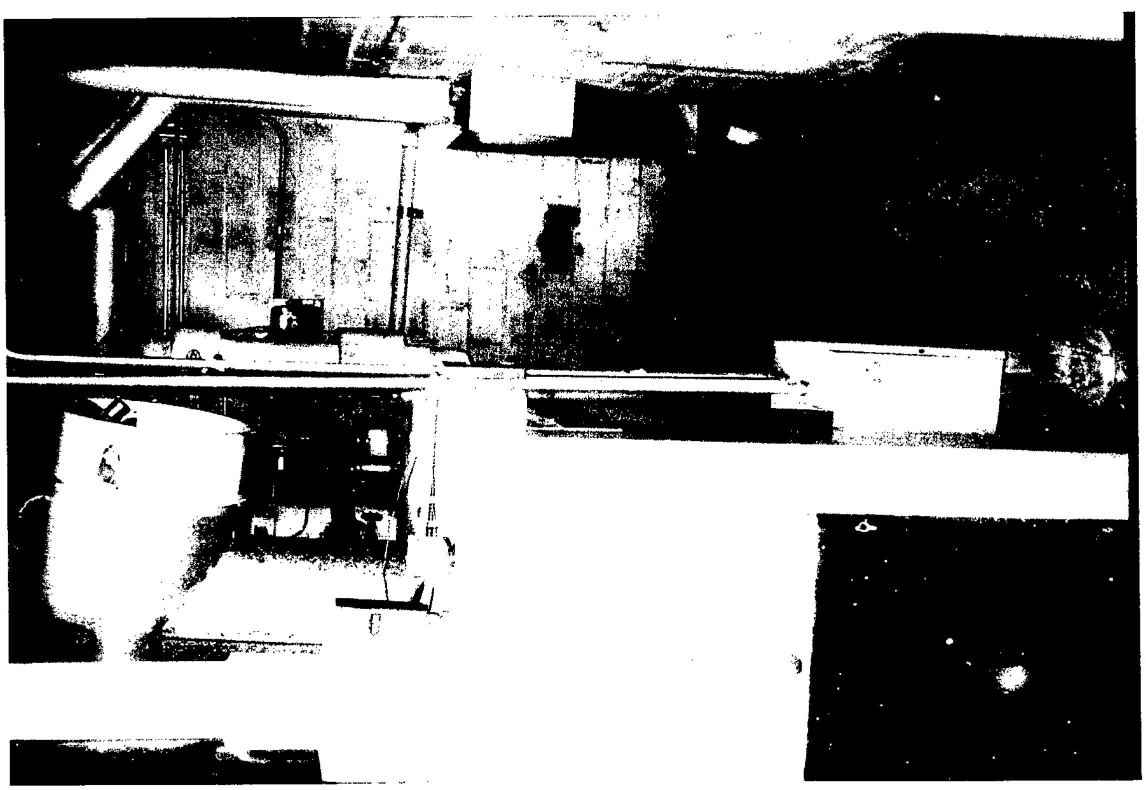

Air cooled chiller serving buildings 134 & 135 (foreground)



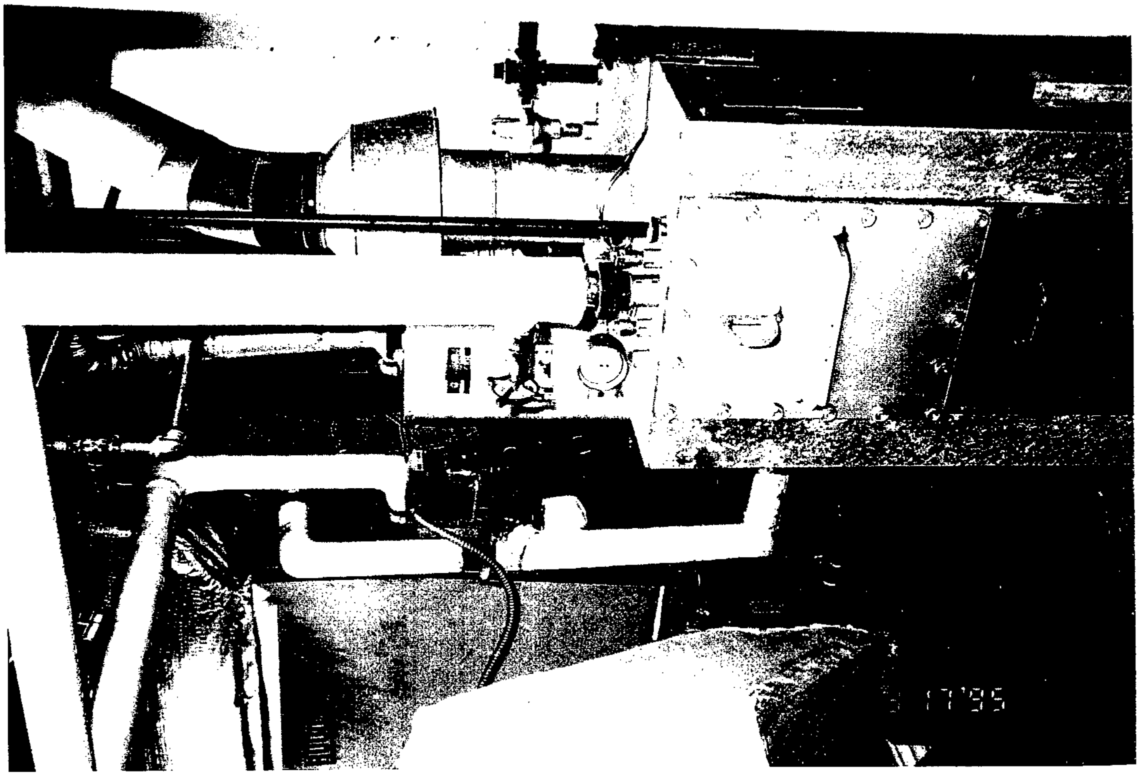
Air cooled chiller serving building 133.



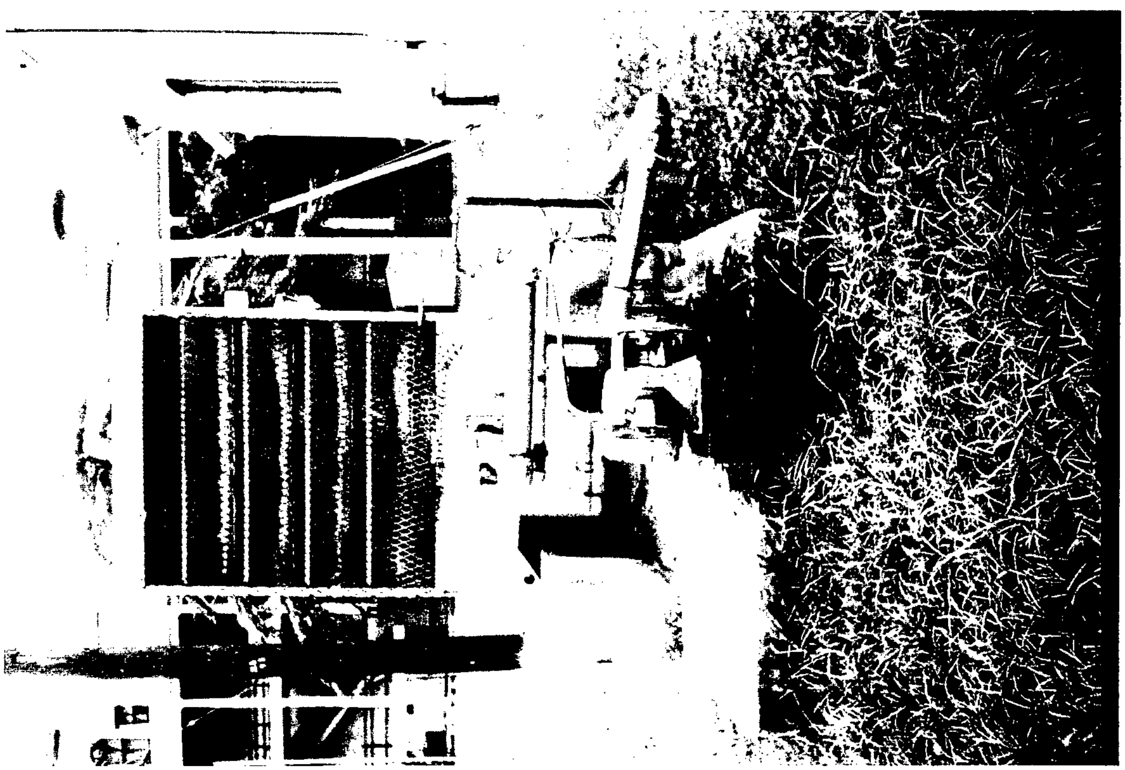
HW boiler serving building 133.



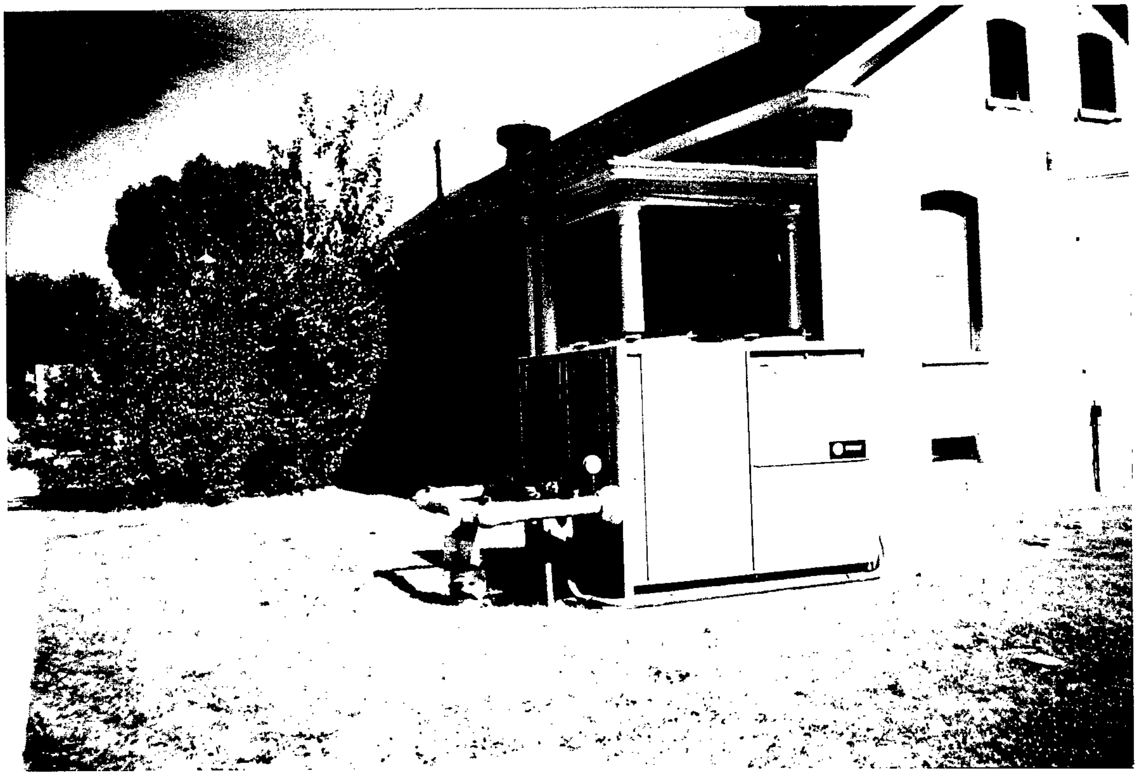
HW boiler serving building 124.



HW boiler serving building 199.

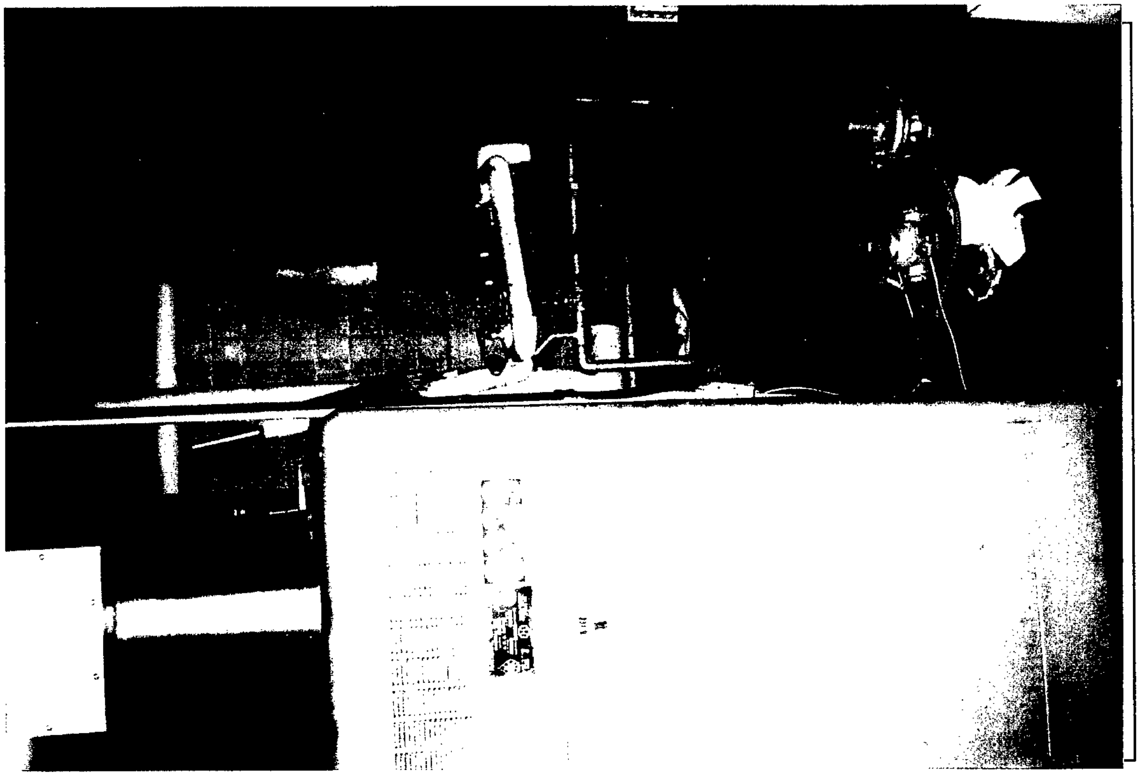


Cooling tower serving building 123.

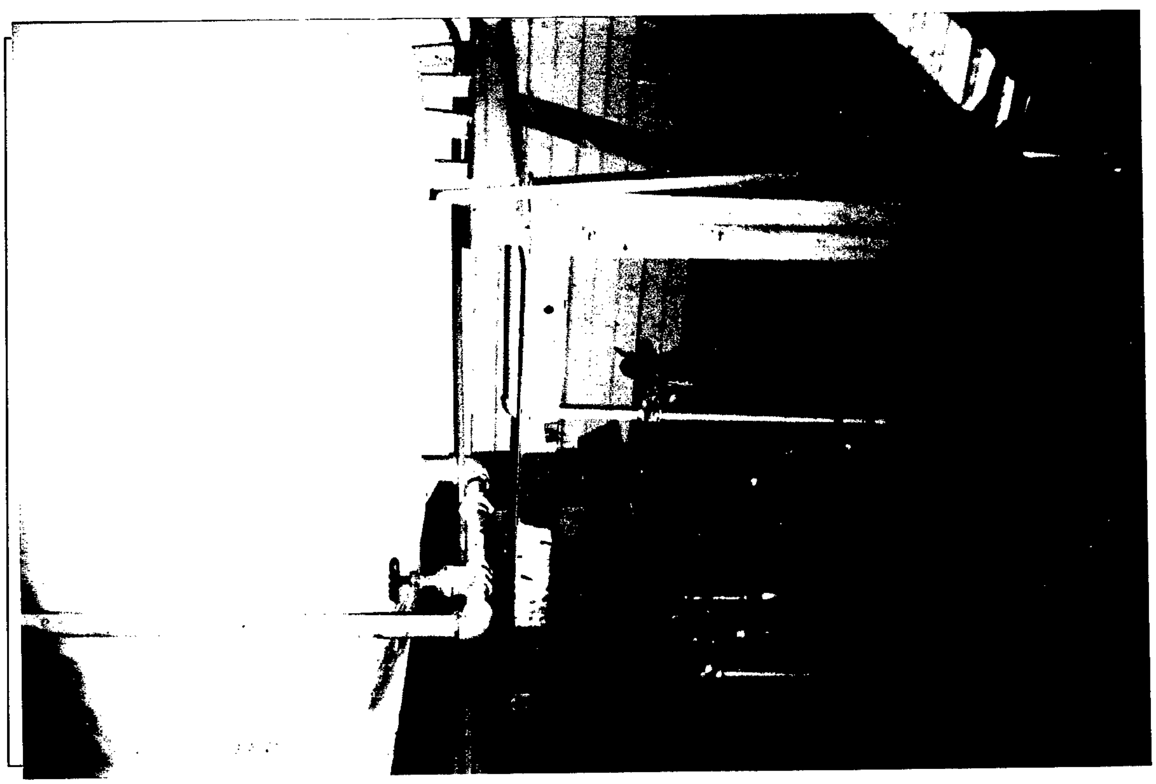


Air cooled chiller serving building 126

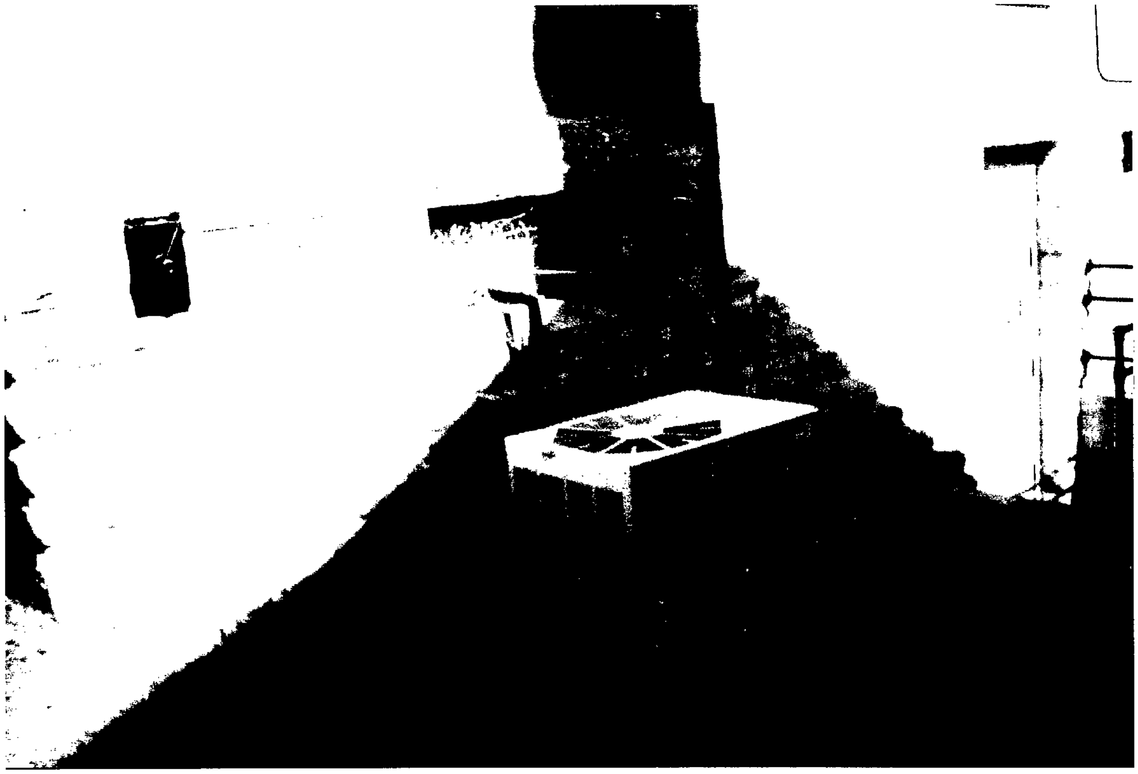
Temporary air cooled chiller serving building 129 while existing chiller is under repairs.



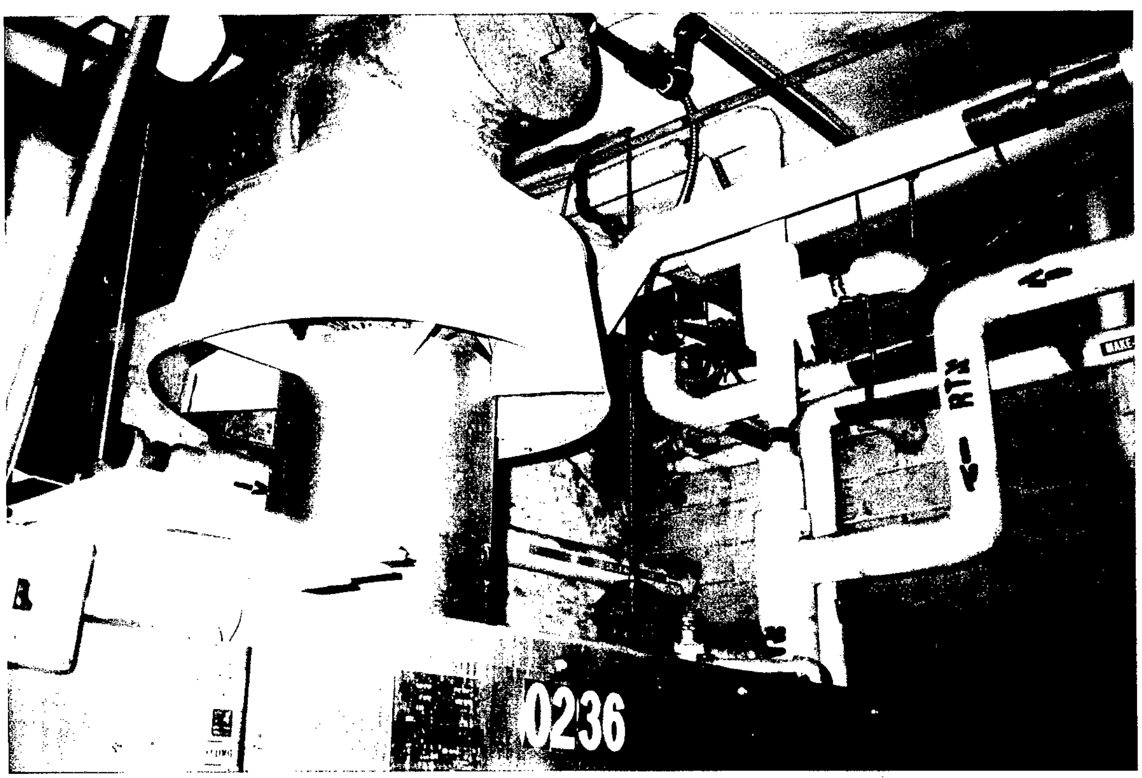
HW boiler serving building 126



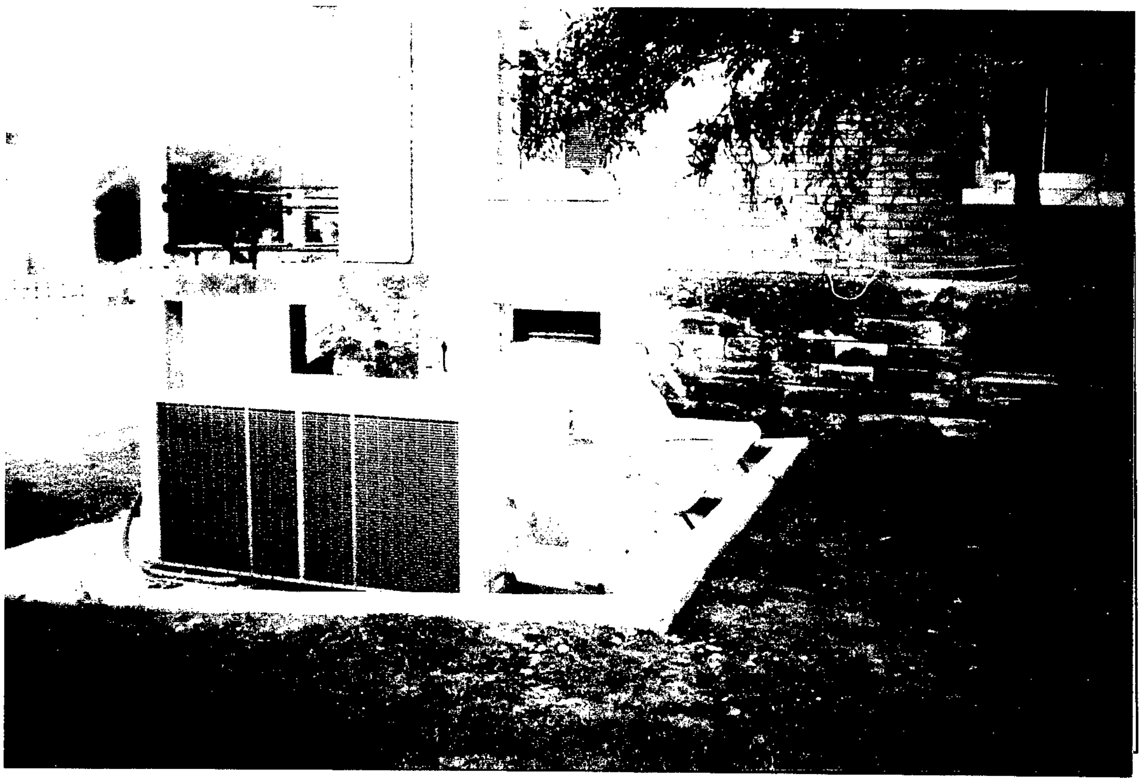
Abandoned steam boiler and heat exchanger (DHW generator) serving building 156.



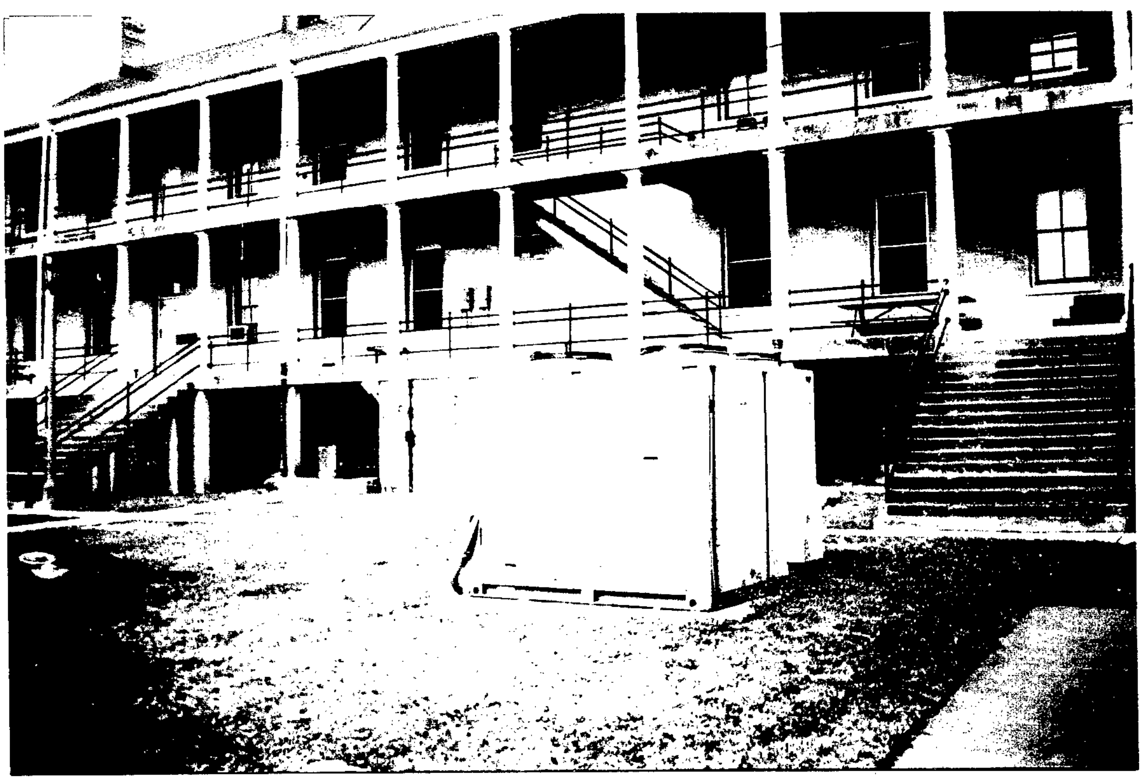
Split system condensing unit serving partial basement of building 129.



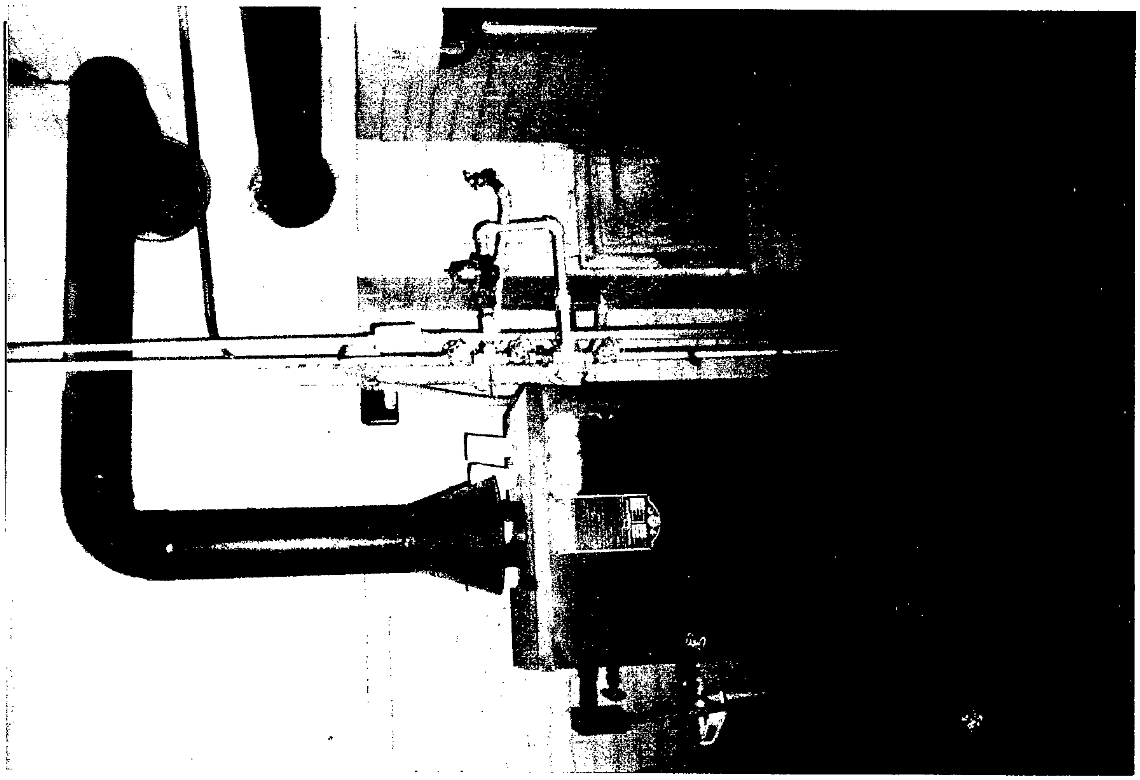

Four (4) pipe to two (2) pipe manual change-over arrangement for building 129 (typical).



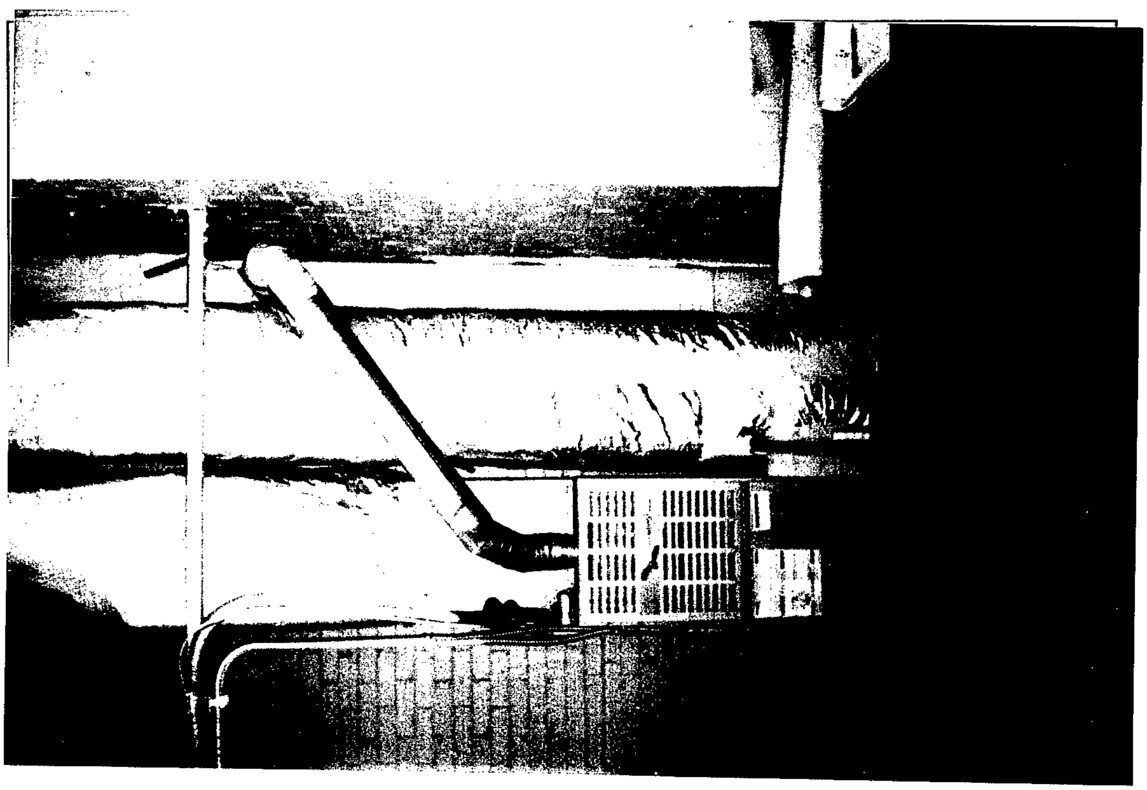
New air cooled chiller serving building 131.



Air cooled chiller serving building 126.



HW boiler serving building 156 (HW pump operates 24 hours/day, year round).

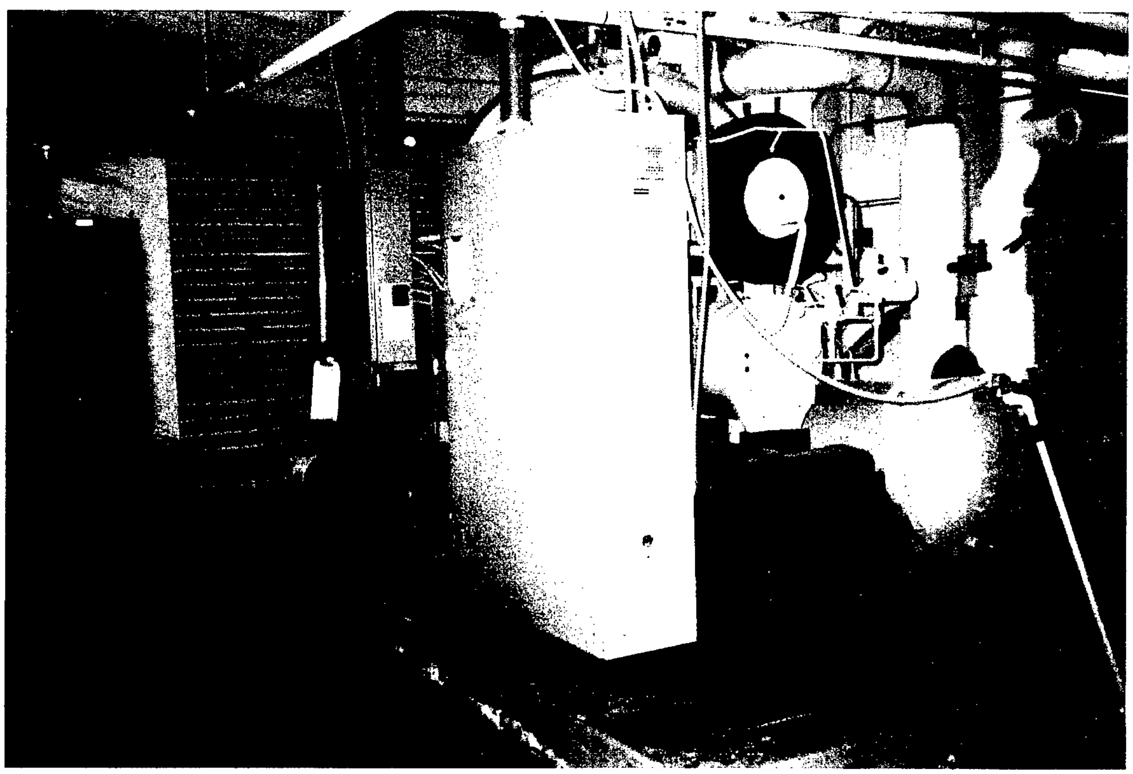


Residential type furnace unit serving building 159.

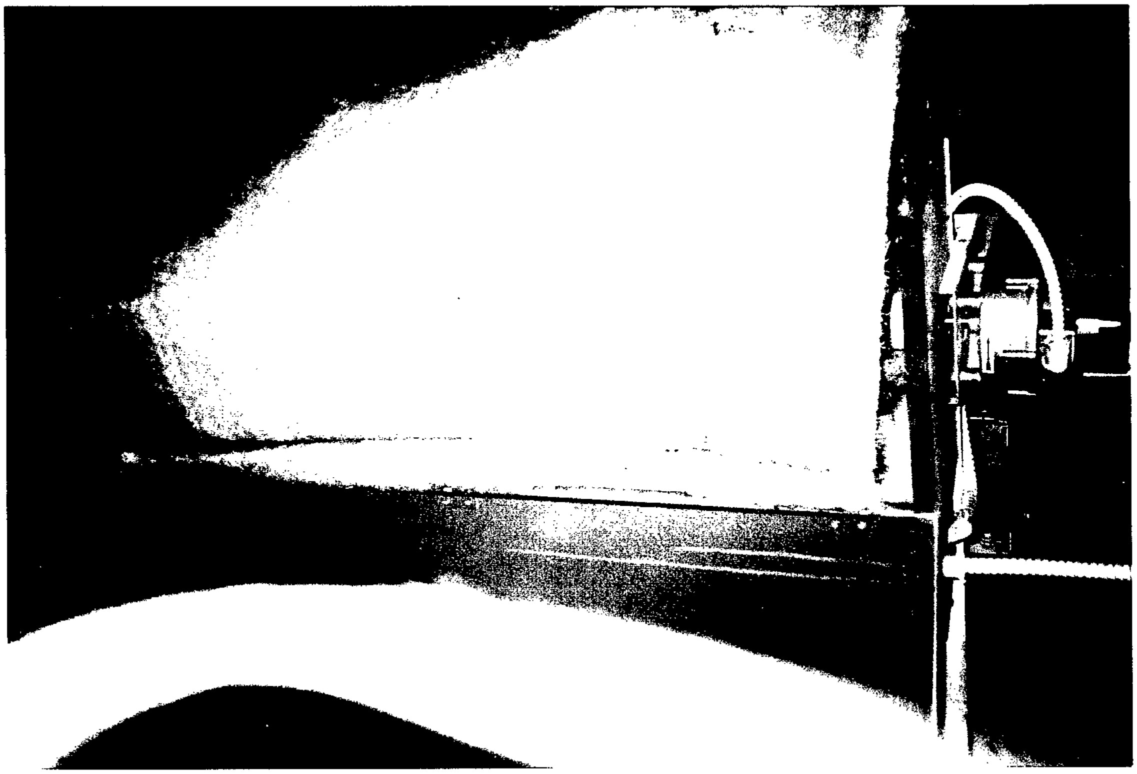

Air cooled chiller serving building 590

HW boiler (left) and DHW steam boiler (right) serving building 590 located in the basement.

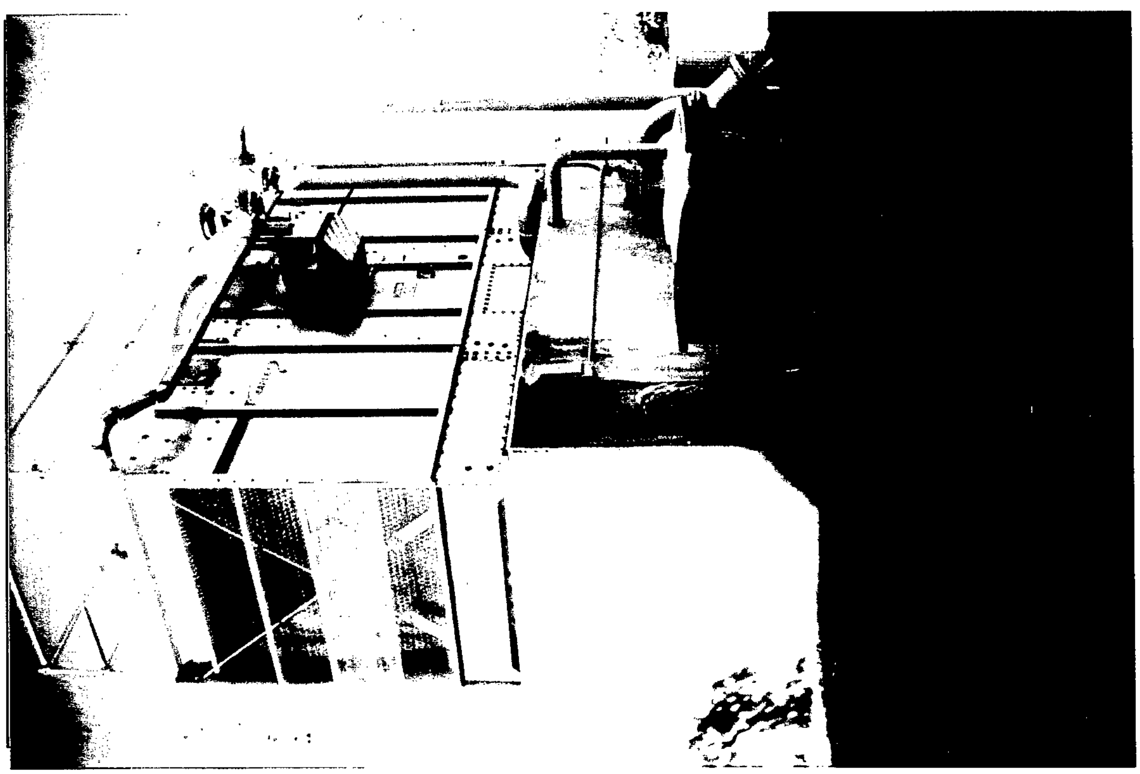
Air cooled chiller serving building 590.



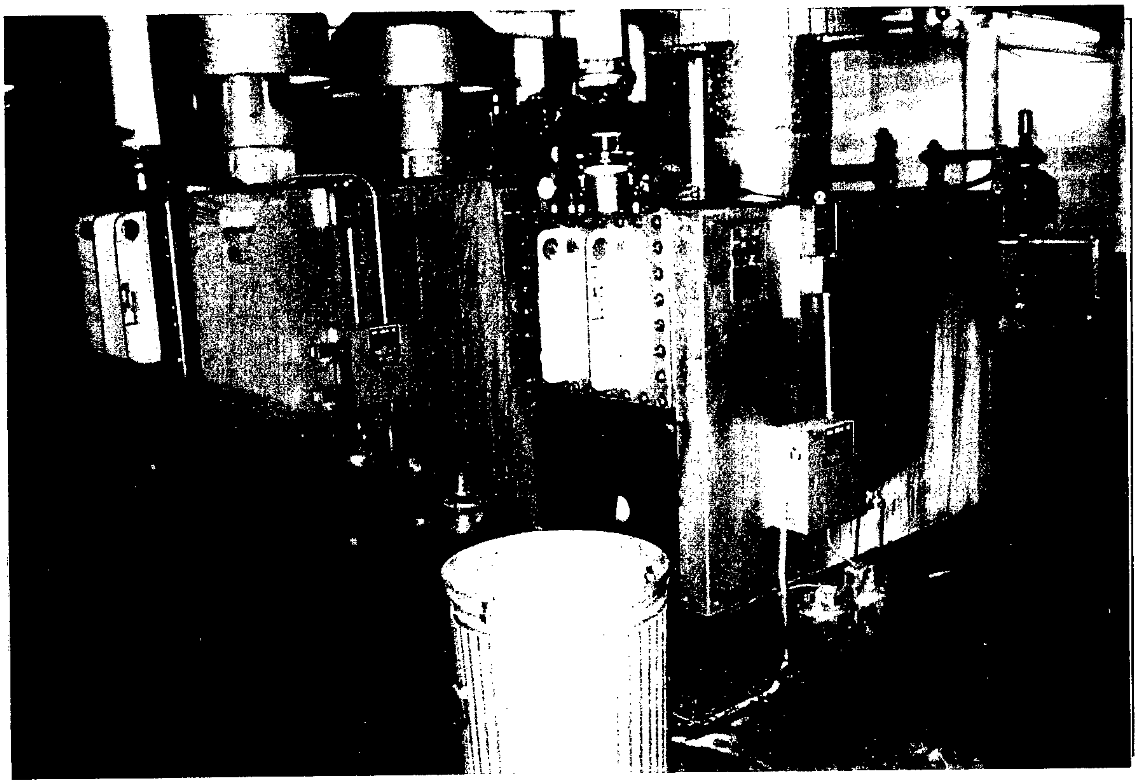
New water cooled centrifugal chiller with economizer section serving building 592.



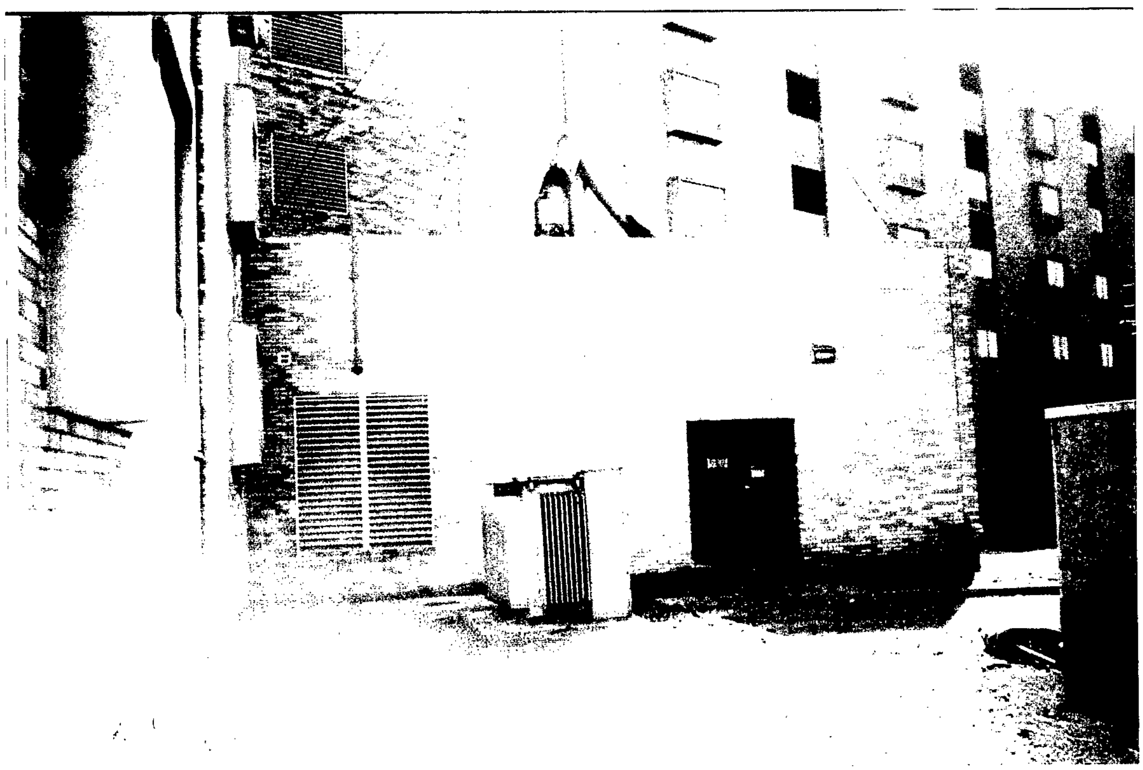
Roll filter in AHU , second floor - building 592, installed backwards.



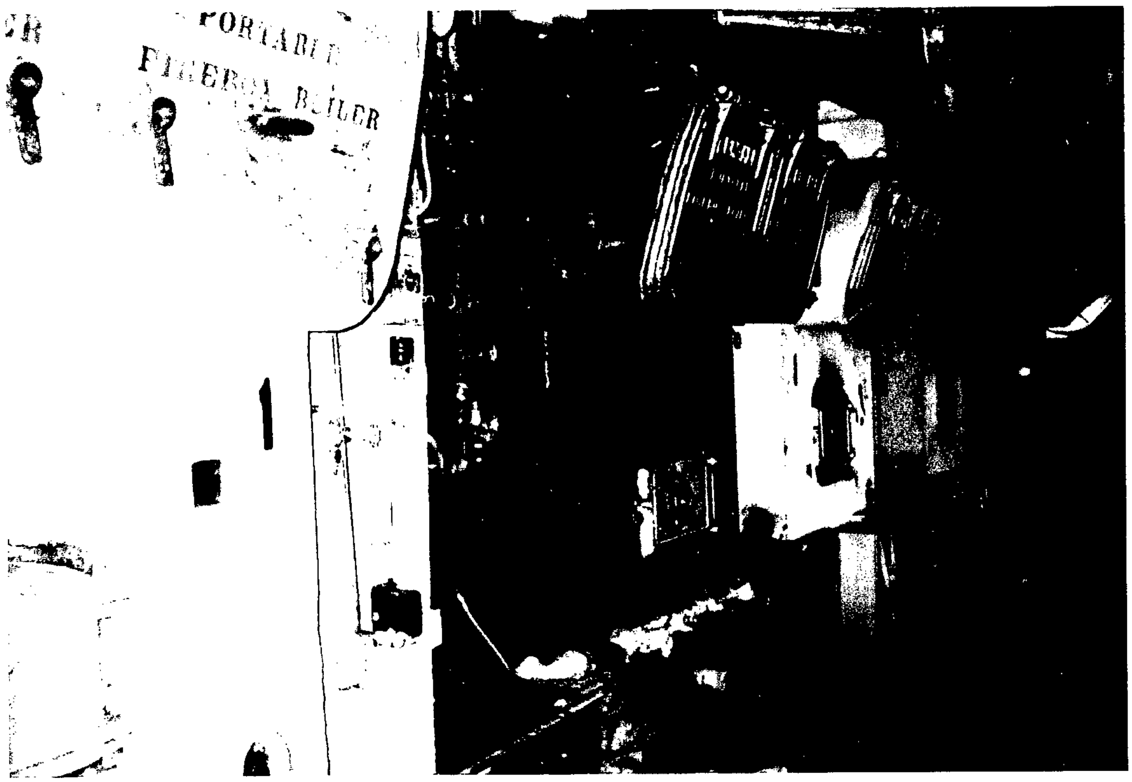
Cooling tower serving building 592 chiller.



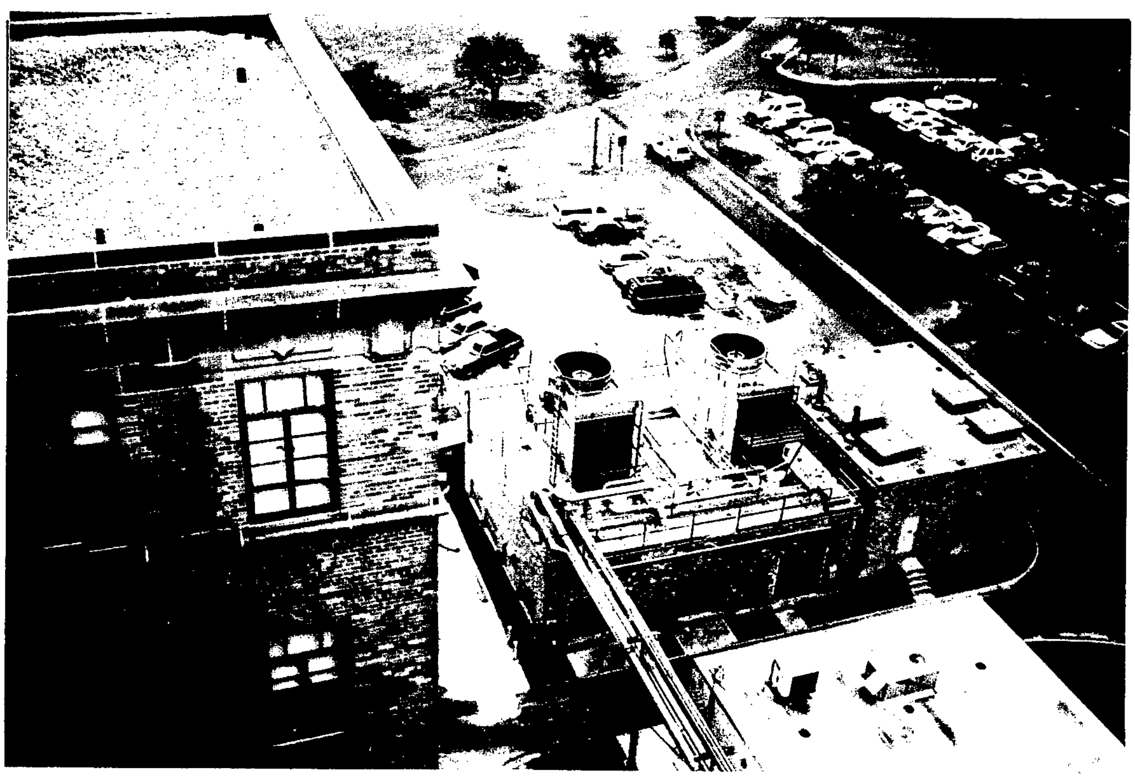
HW boiler (right) and DHW boiler (left) serving building 592.



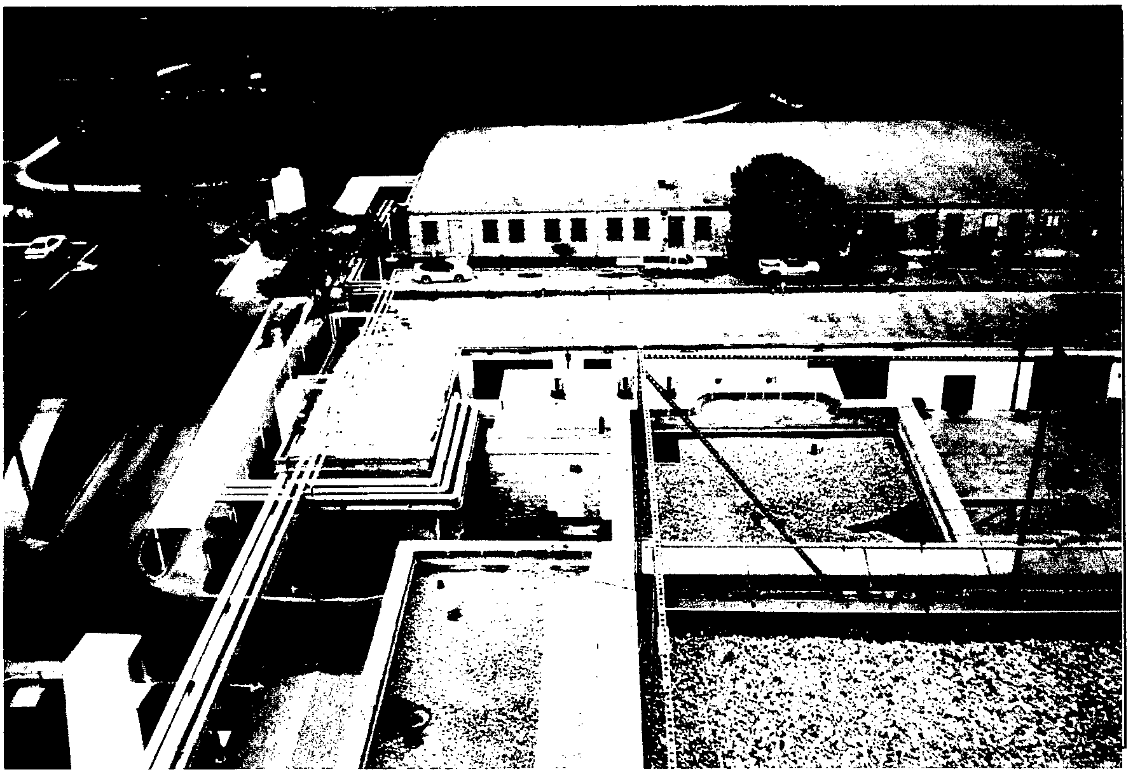
Building 592 central plant and proposed location of central plant addition.



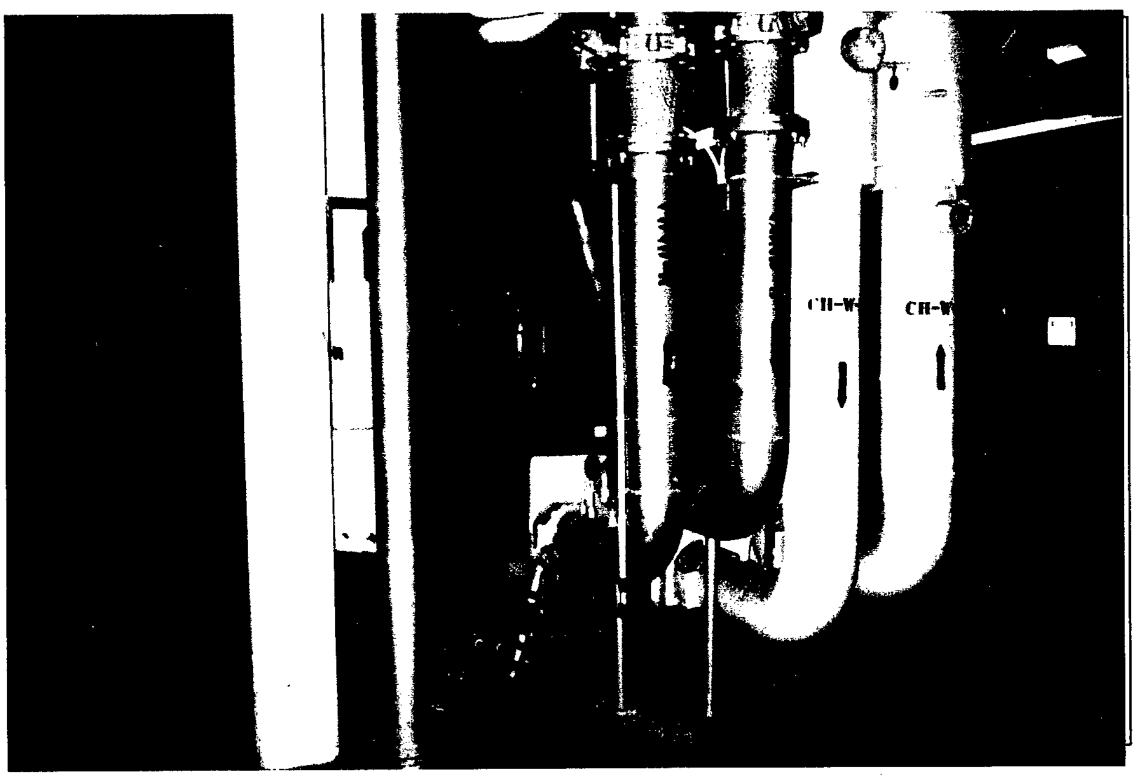
Two (2) condemned HPS boilers, and three (3) LPS boilers which serve convectors in bldg. 1000.



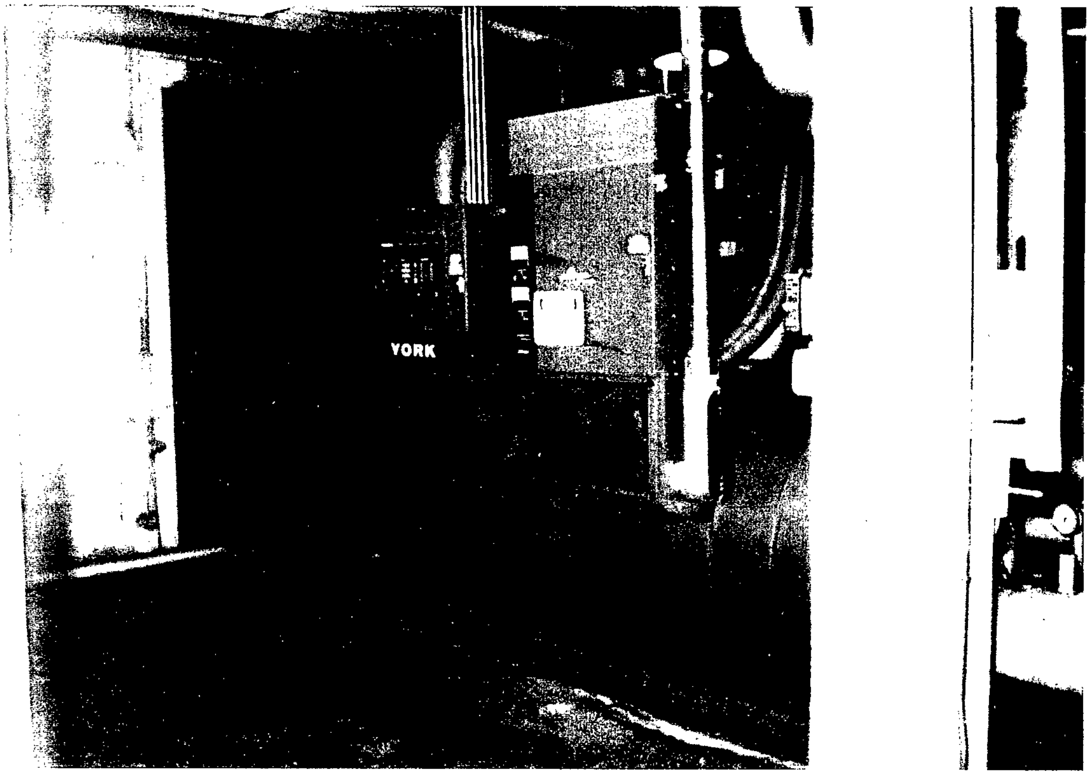
Cooling towers serving building 1000 located on the top of building 1088.



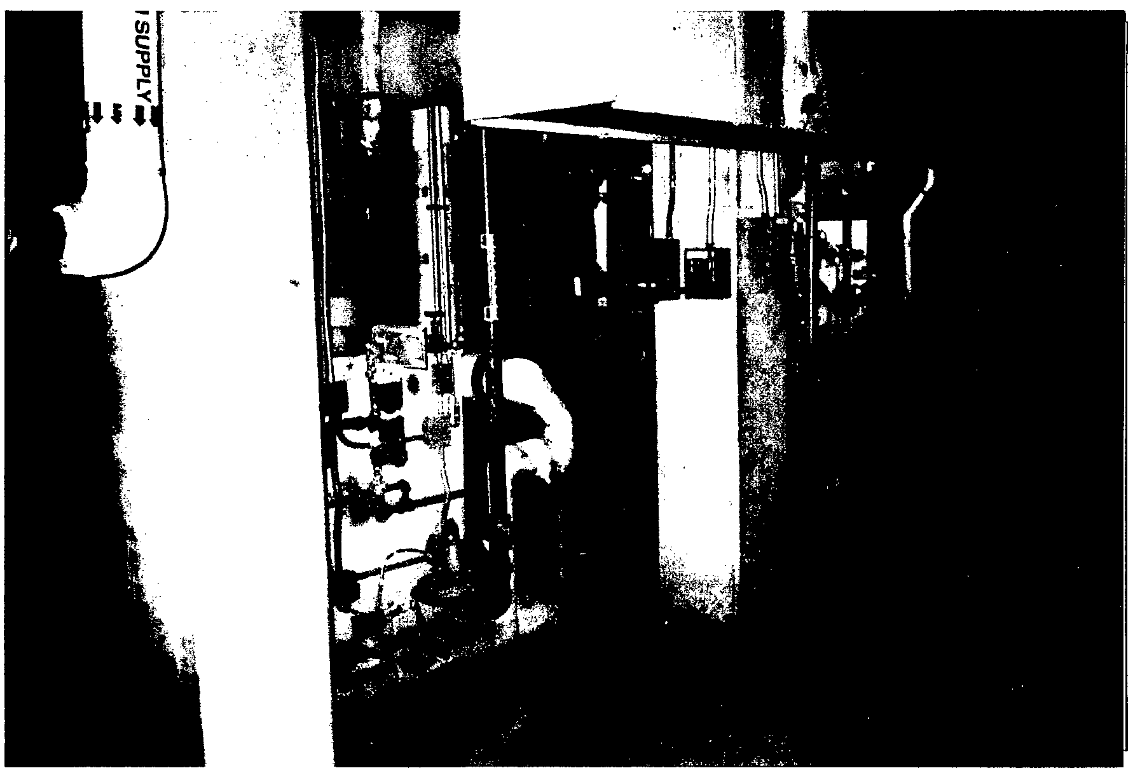
Boiler plant serving building 1000 located on the North side.



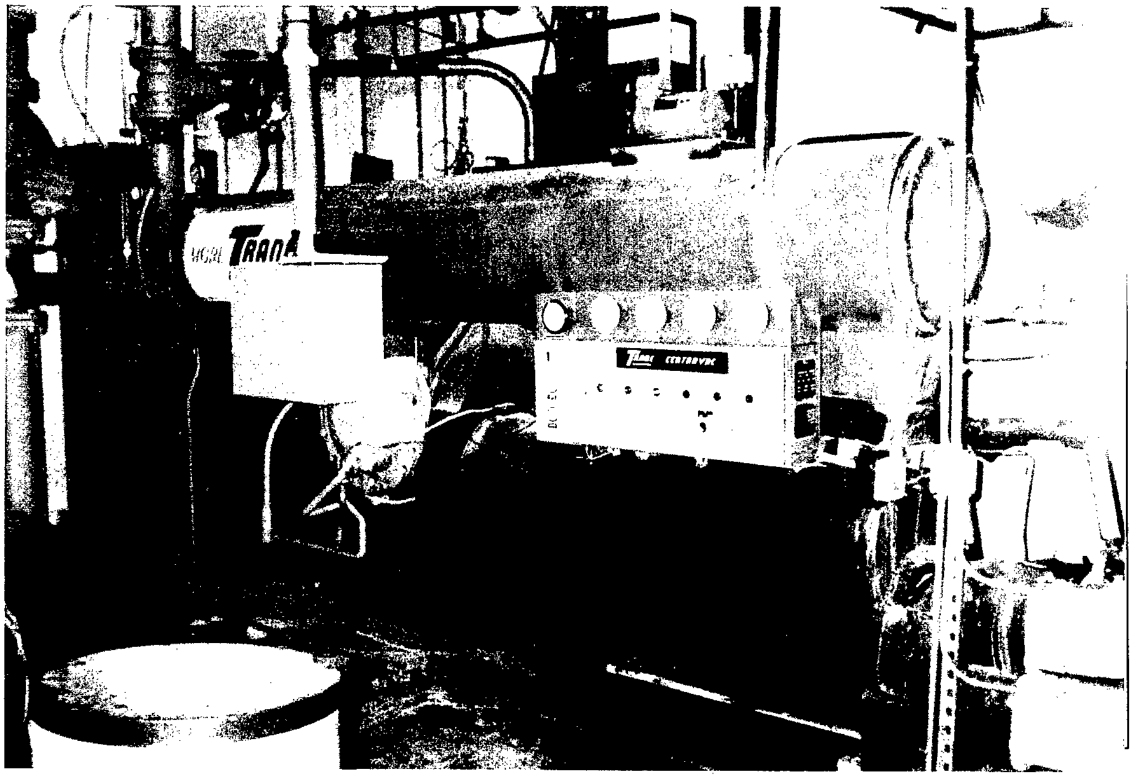

Water cooled centrifugal chiller (CH-1) serving building 1000 located in building 1088.



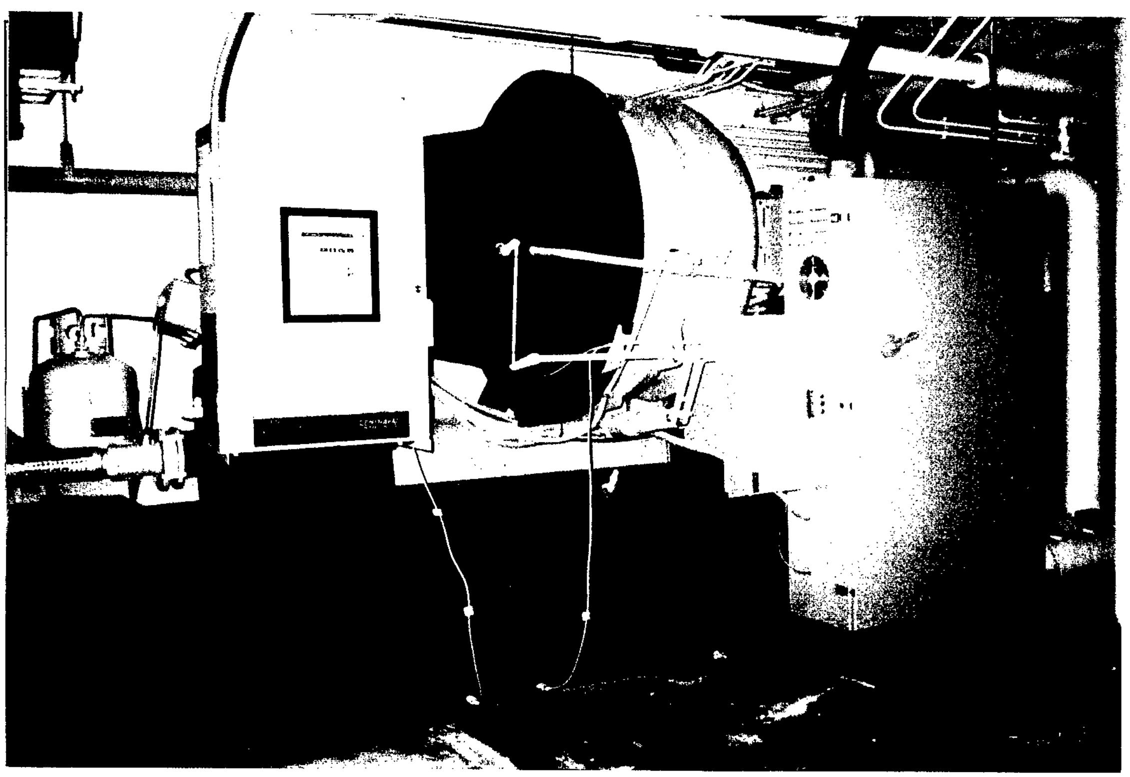

Water cooled centrifugal chiller (CH-2) serving building 1000 located in building 1088.



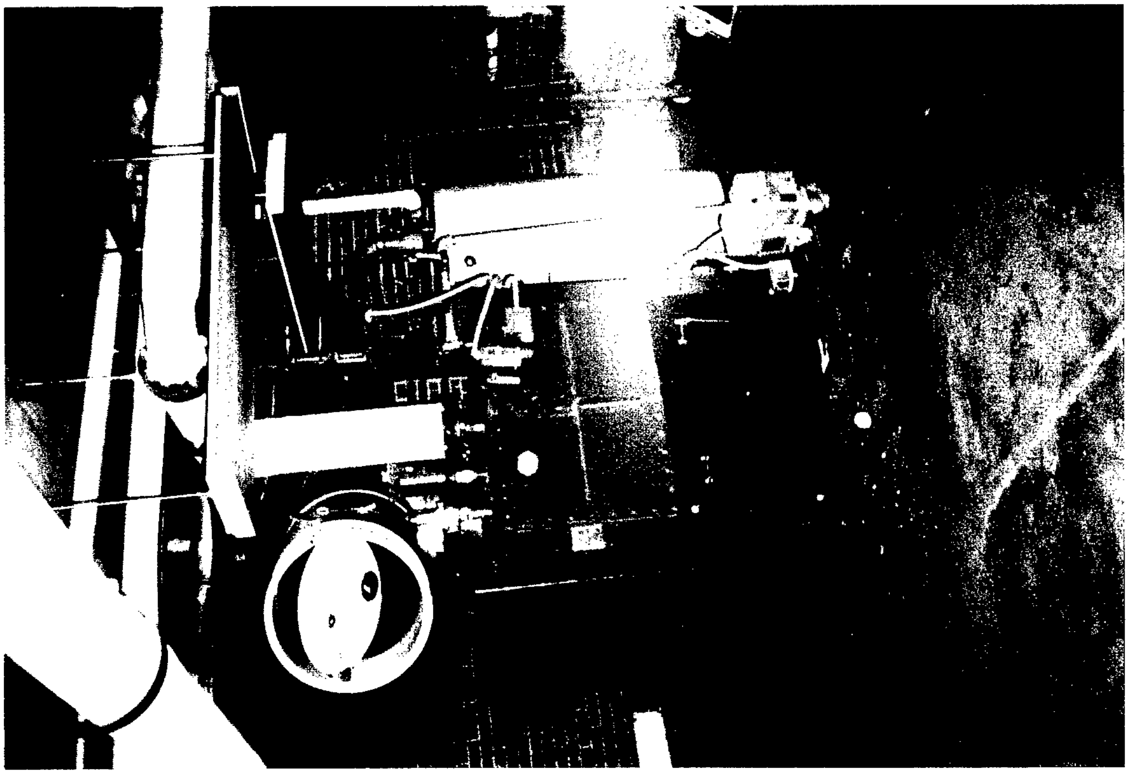

Two (2) abandoned and one (1), far right, operational steam boiler in basement of building 1001.



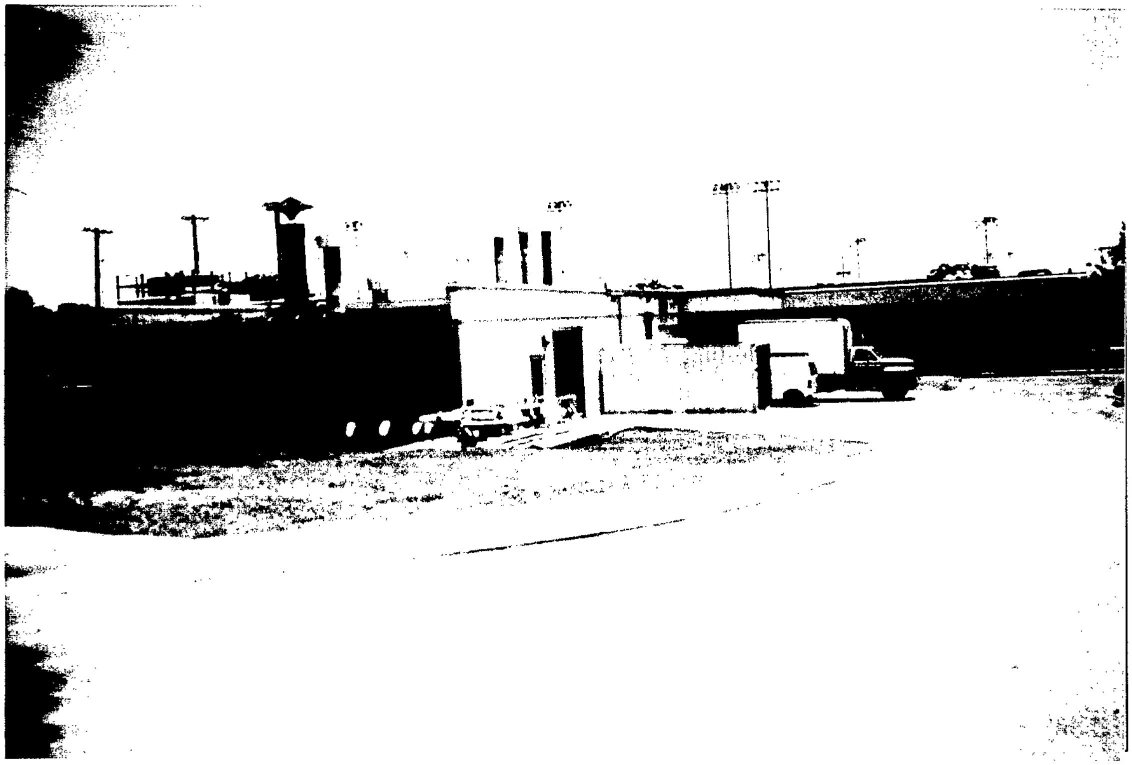

Water cooled centrifugal chiller serving building 1001 and located in building 1002.



New water cooled centrifugal chiller serving building 1029 located in basement of building.

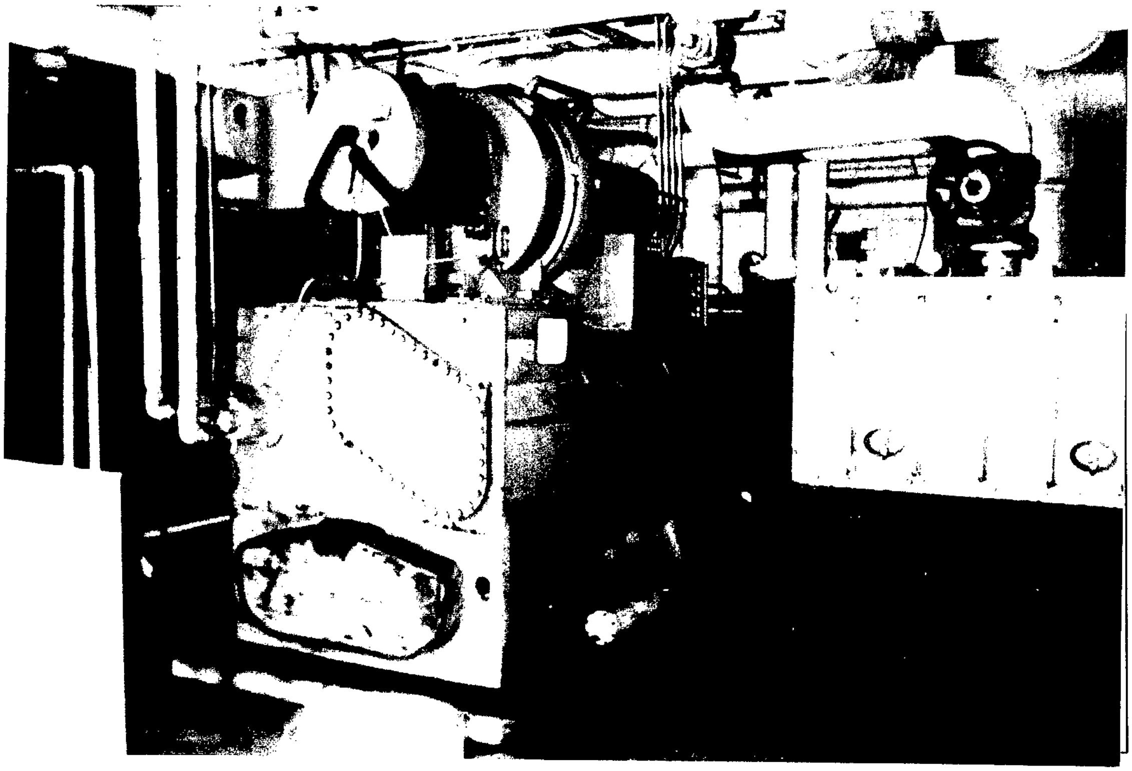


HW boiler and DHW heater serving building 1029 located in basement.

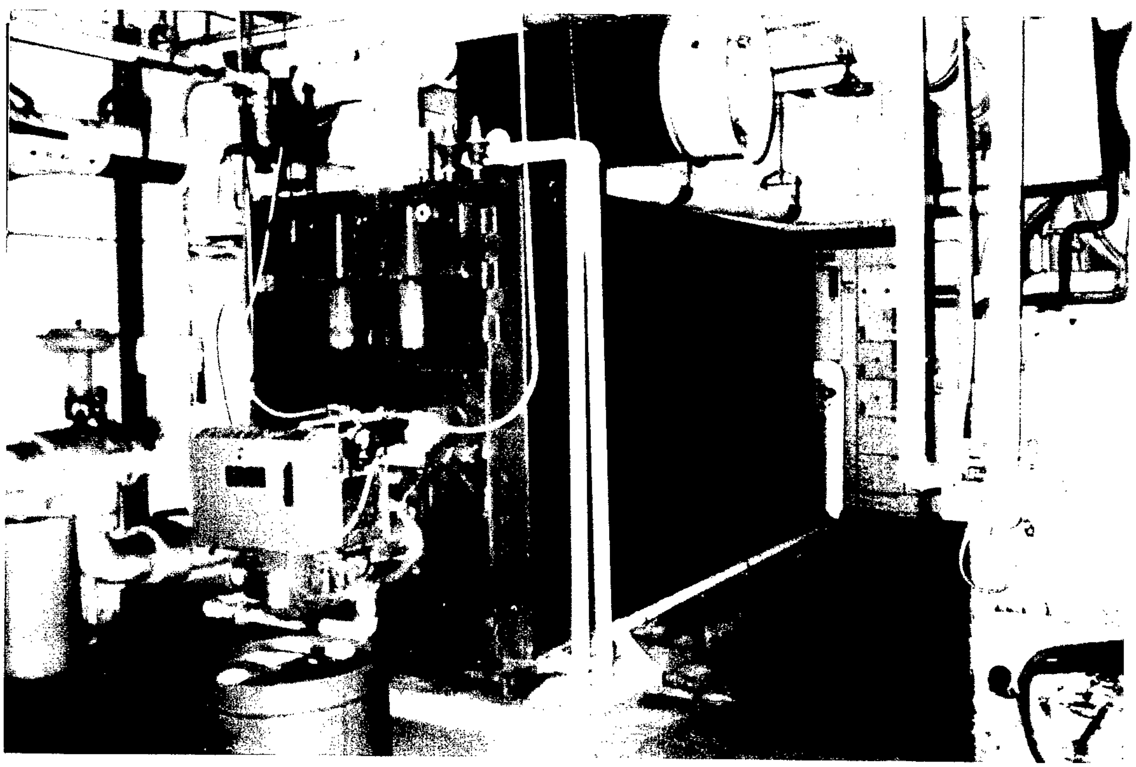


Bldgs.1350, 1374, 1375,1377, 1379, & 1380 central plant located adjacent to bldg. 1377.

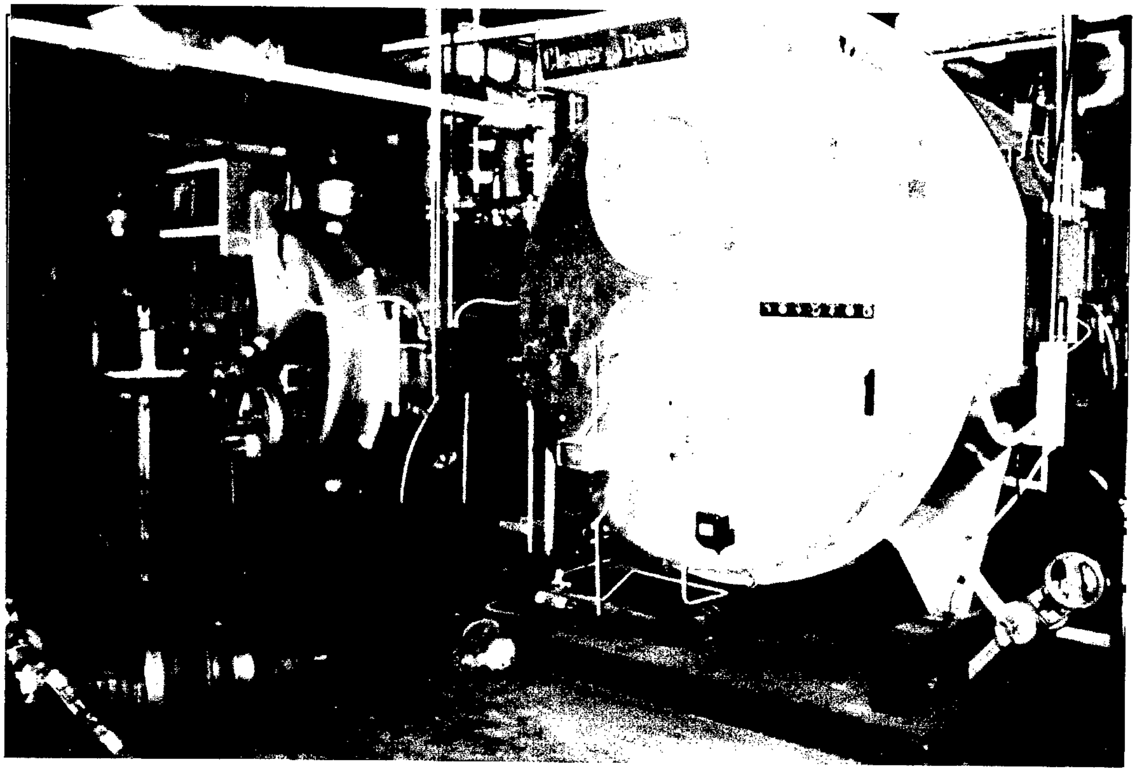
Bldgs.1350, 1374, 1375,1377, 1379, & 1380 cooling towers.



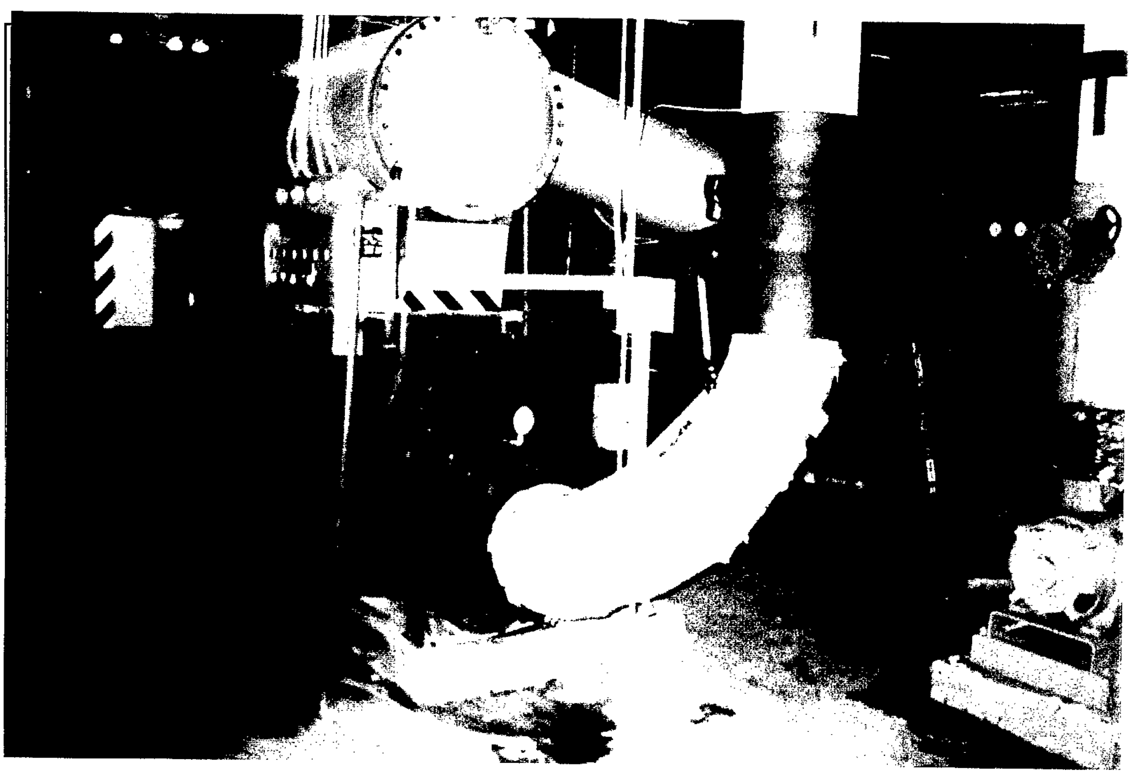
Building 1350 water cooled centrifugal chiller and the second of two (2) HW boilers.



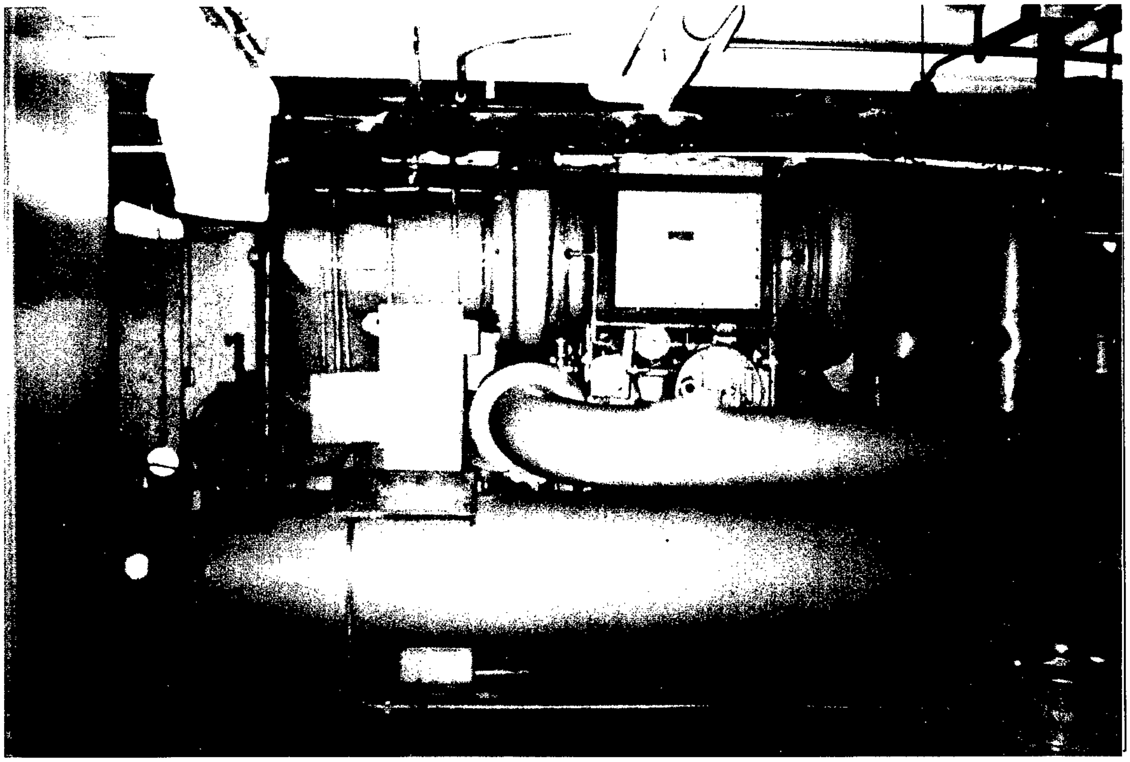
The first of two (2) HW boilers serving building 1350.



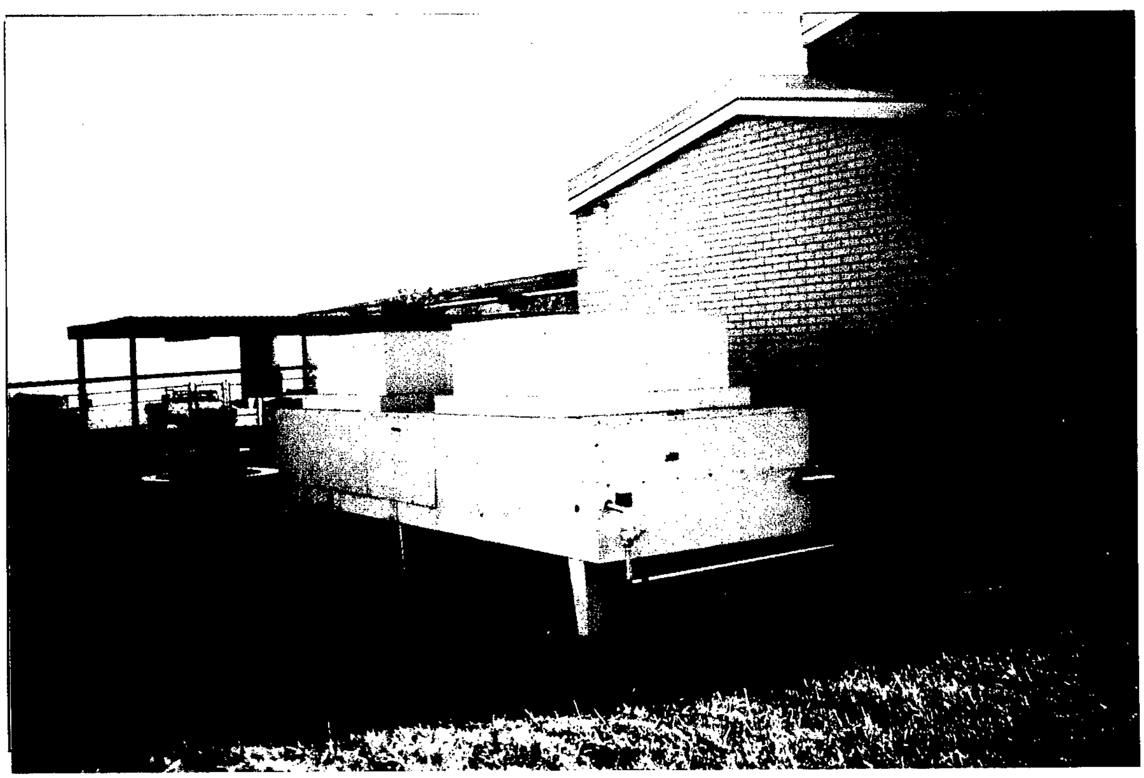
Two (2) HW boilers and one (1) steam boiler serving bldgs. 1374, 1375, 1377, 1379, & 1380



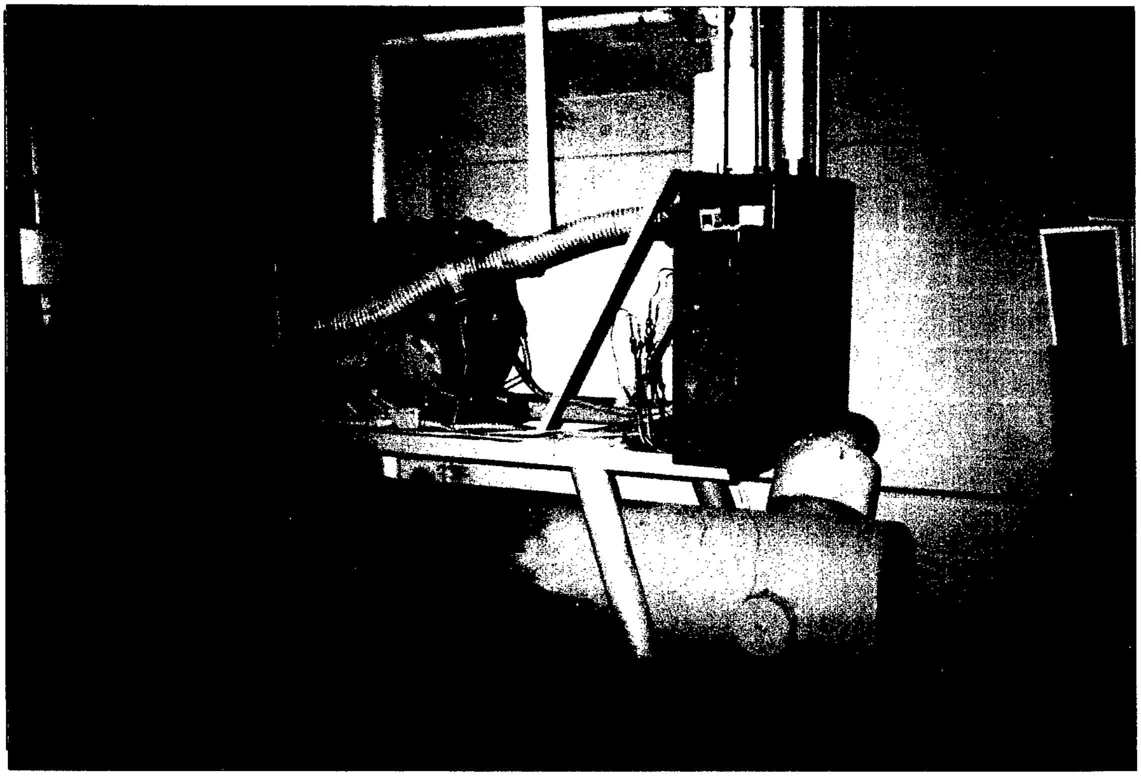
First of two (2) water cooled centrifugal chillers serving bldgs. 1374, 1375, 1377, 1379, & 1380.



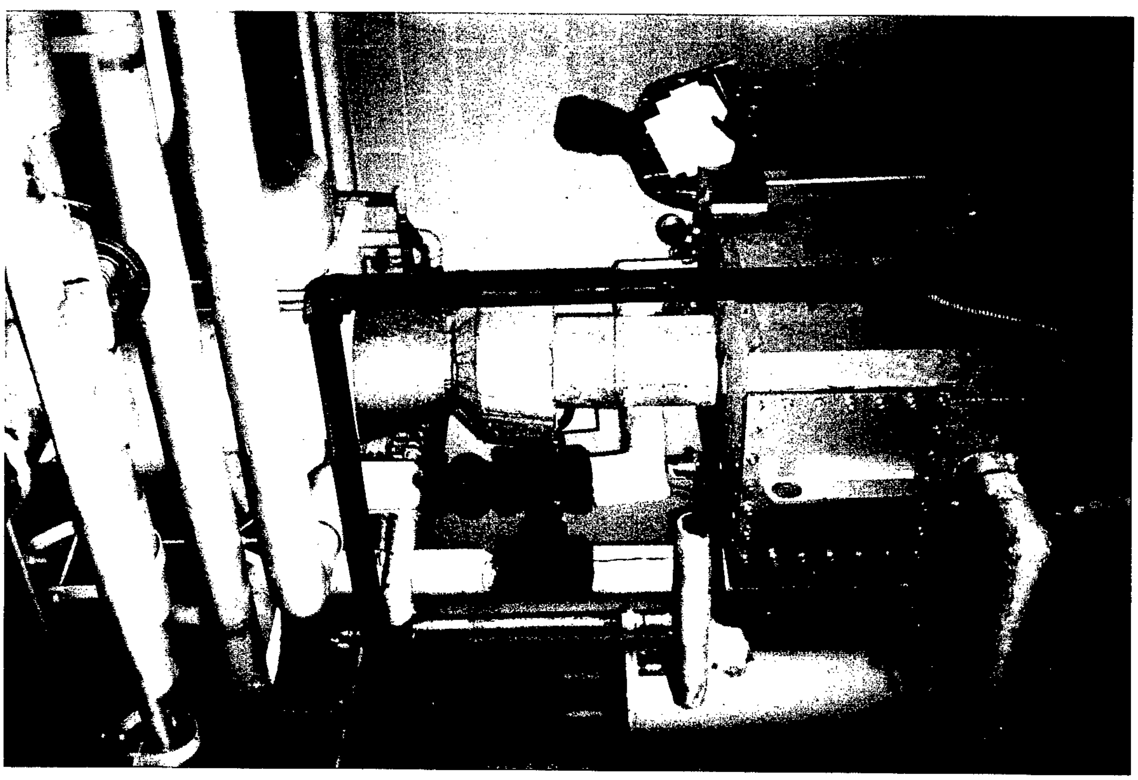
Second of two (2) water cooled centrifugal chillers serving bldgs. 1374, 1375, 1377, 1379, & 1380



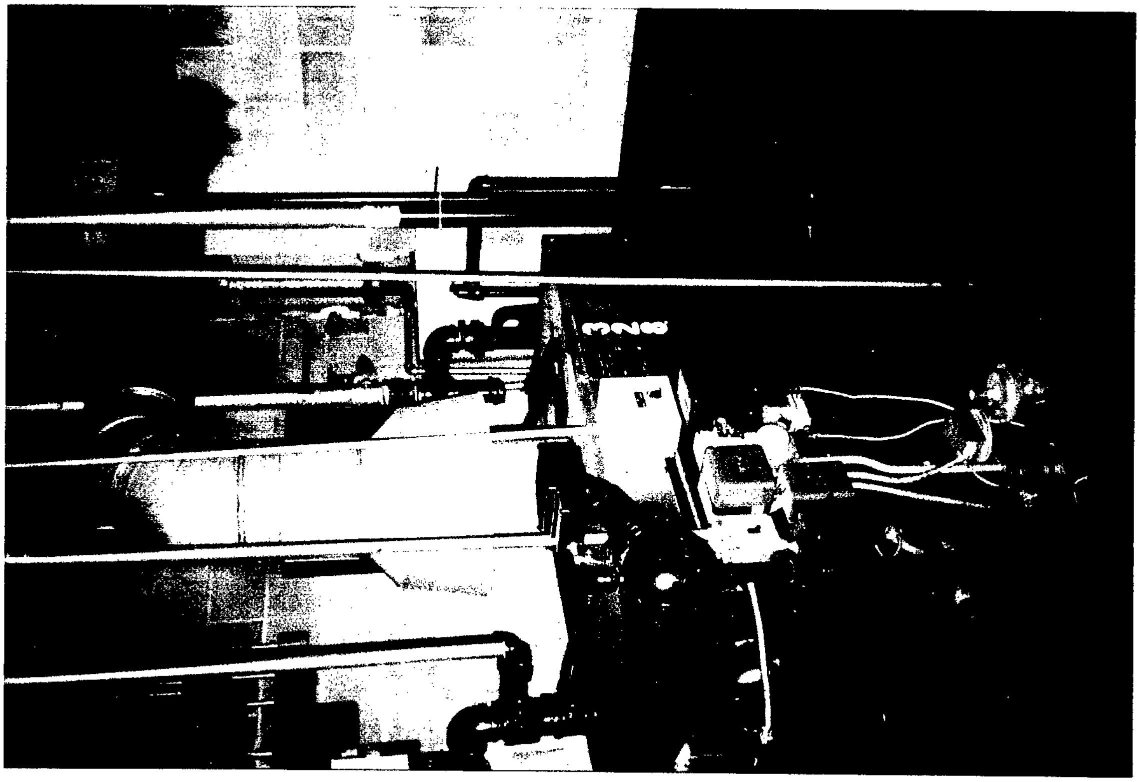
Air cooled condenser serving building 1398.



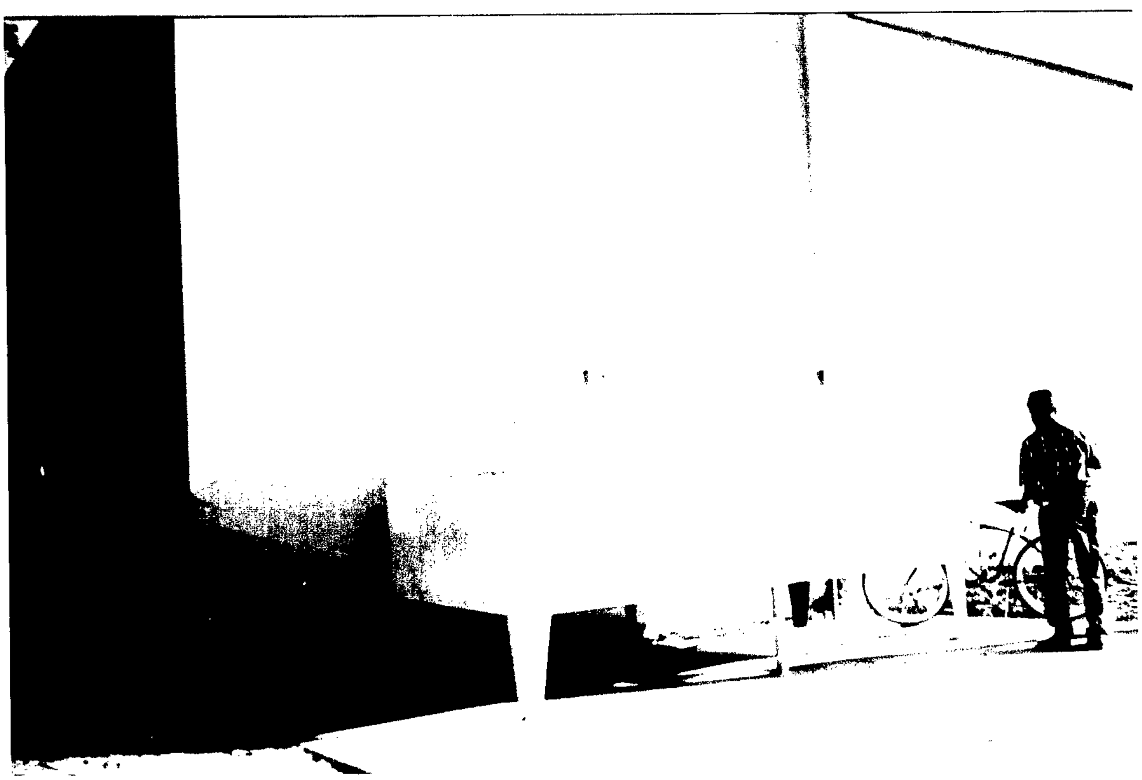
Hermetic chiller serving building 1398



HW boiler serving building 1398.



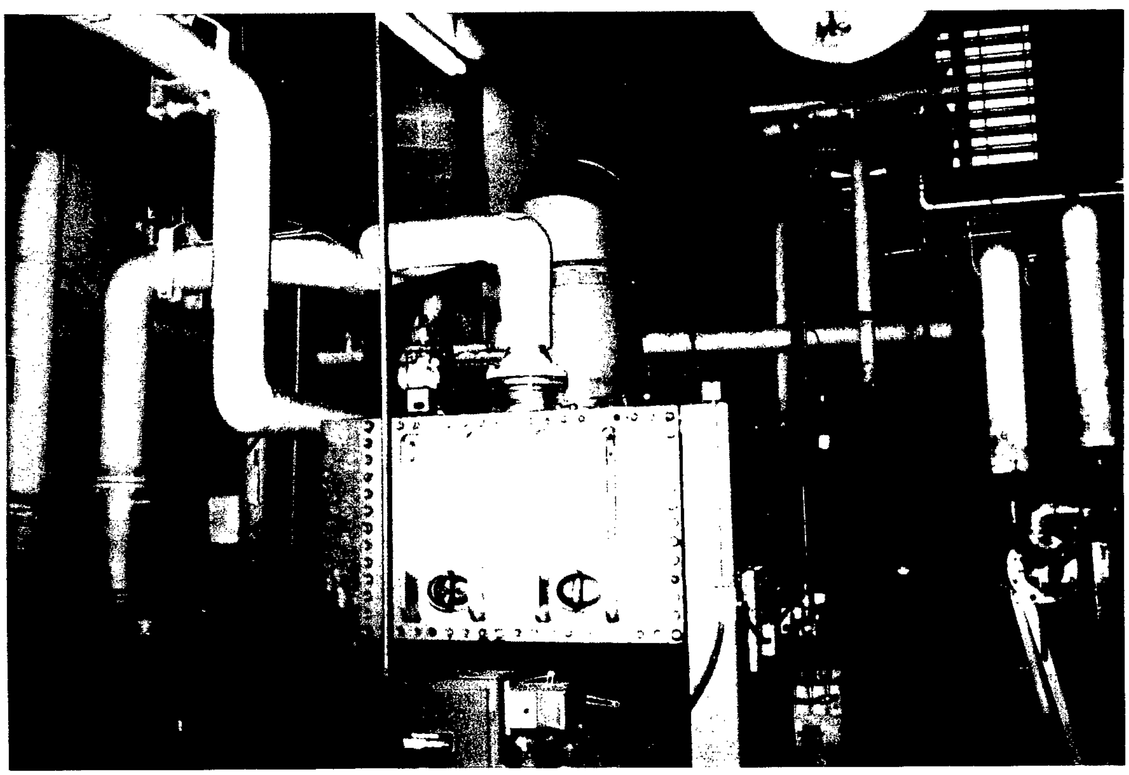
HW boiler serving building 1396.



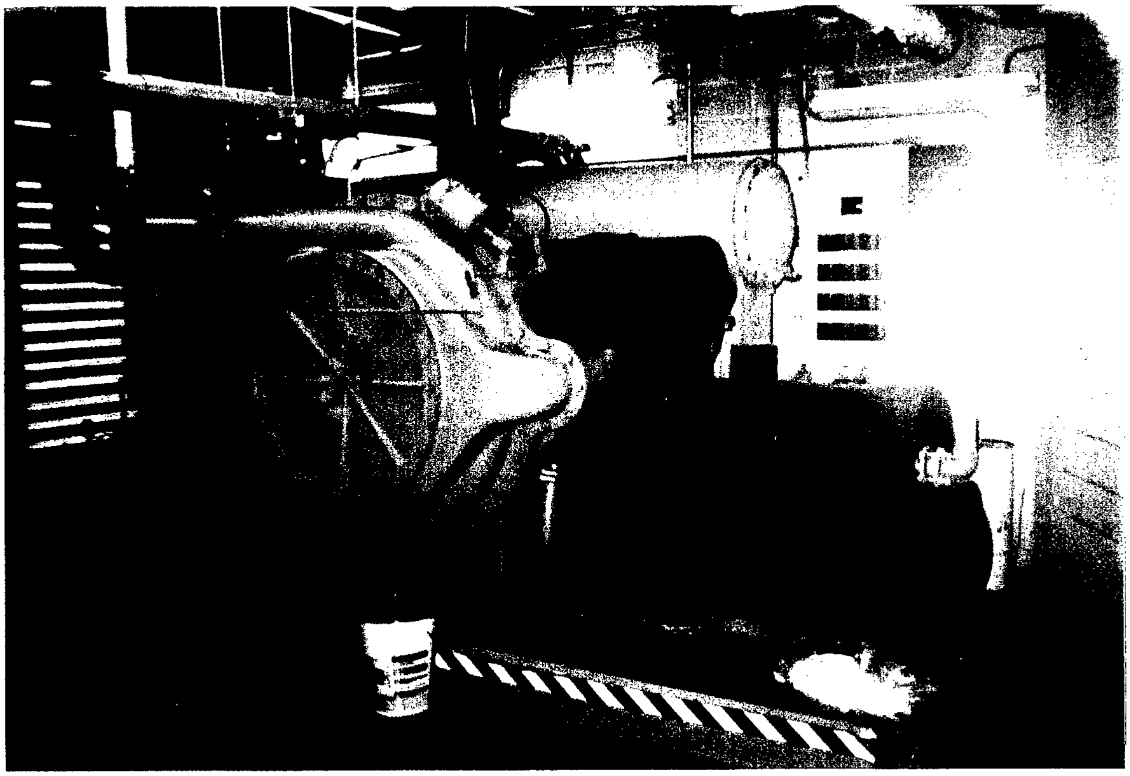
Air cooled condenser serving building 1396.

HUITT-ZOLLARS, INC.
ENGINEERING / ARCHITECTURAL / PLANNING
512 MAIN STREET, SUITE 1500 * FORT WORTH, TEXAS 76102 * (817) 335-3000 * FAX (817) 335 1025

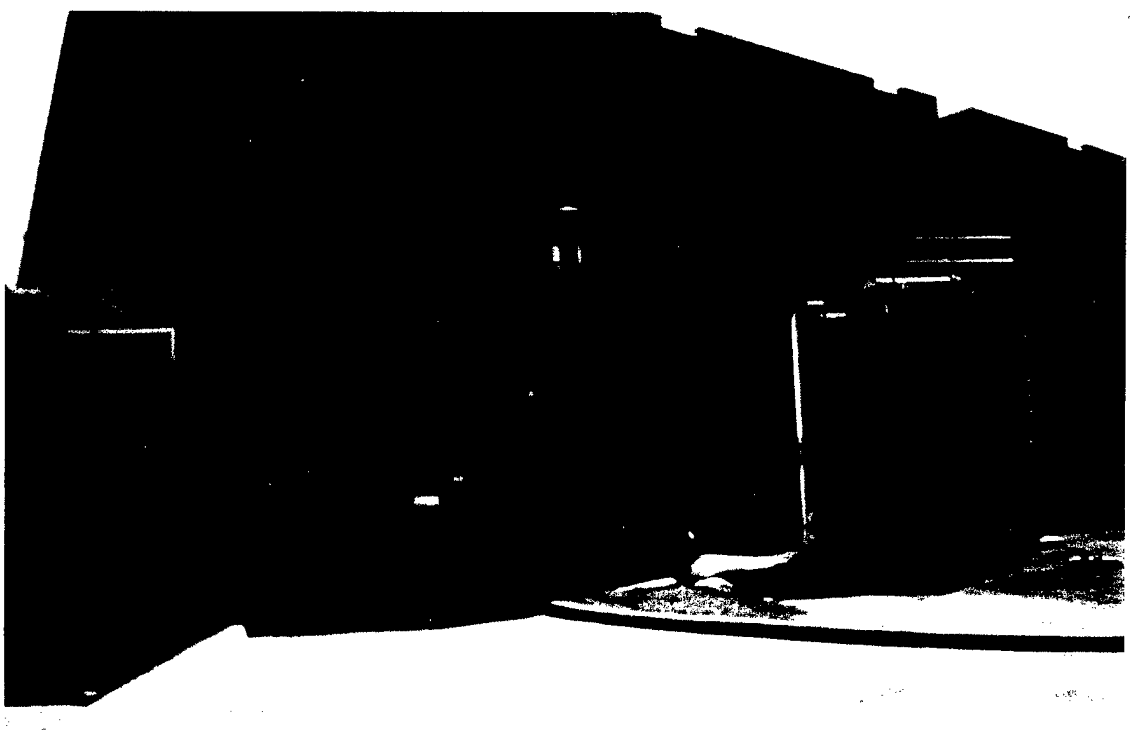
Cooling tower serving chiller for building 1384.



HW boiler serving building 1384.



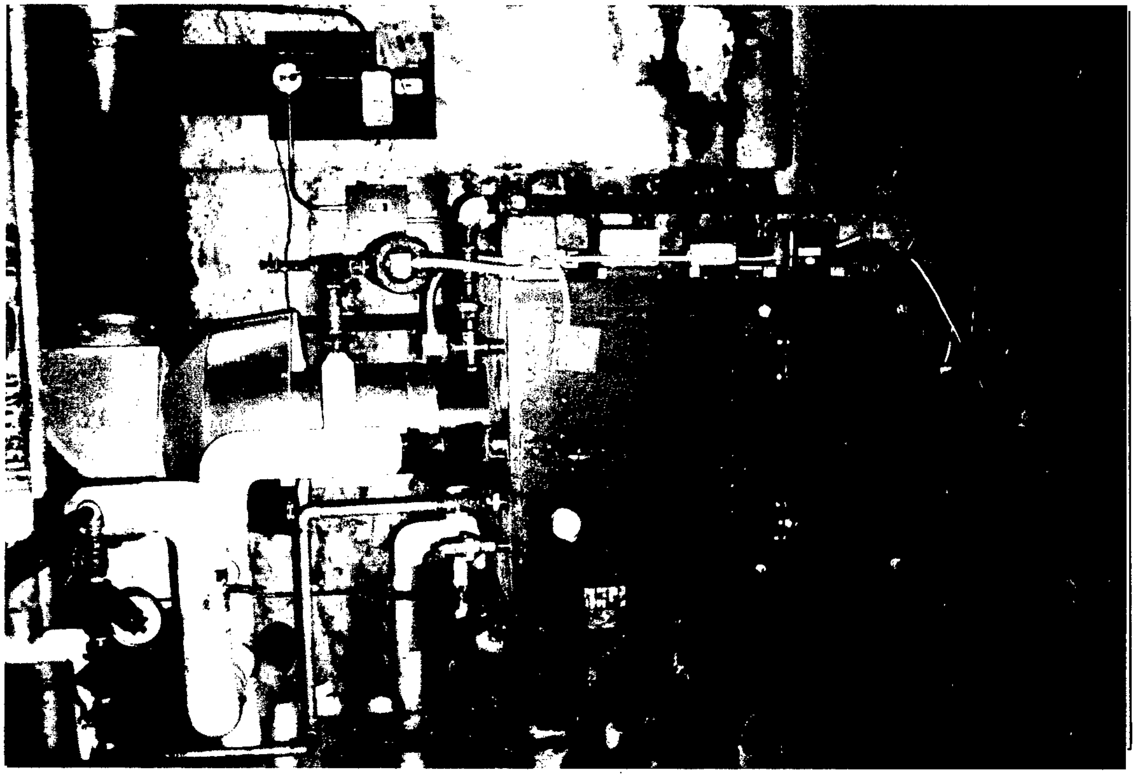
Water cooled centrifugal chiller serving building 1384.



Central plant for building 1384.

Open drive DX compressor and evaporator barrel serving building 2247.

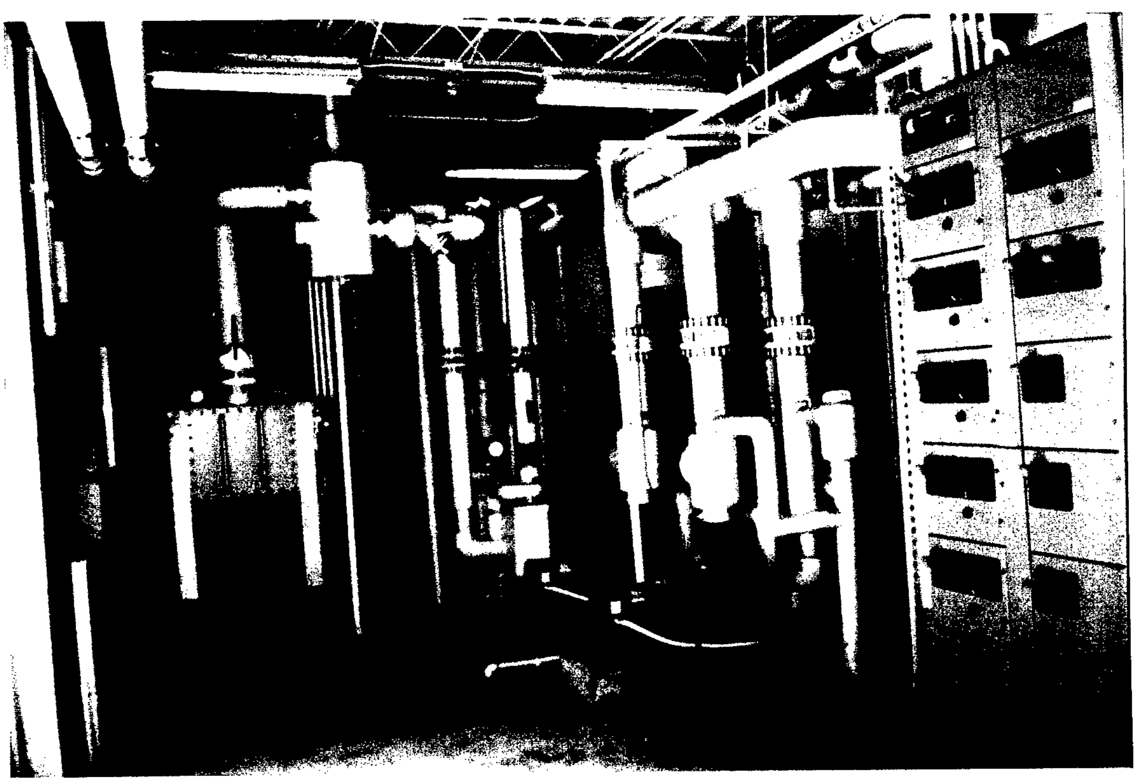
HW boiler serving building 2247. Flooding occurs in this basement.



HW boiler serving buildings 2248 & 2250.

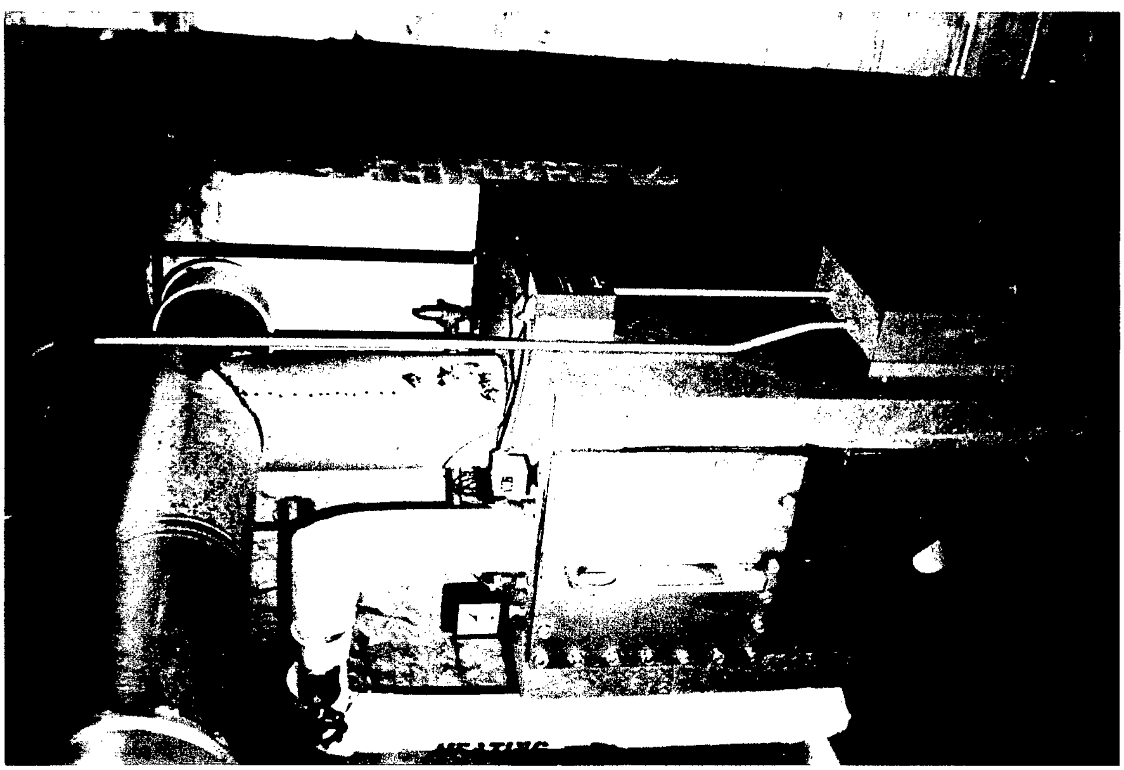
Air cooled chiller serving buildings 2248 & 2250.

Air cooled chiller and boiler plant (behind) serving building 2200.



HW boiler serving building 2200 located in boiler plant.

Condensing unit serving DX AHU in mechanical room of building 2244.



HW boiler serving buildings 2272 & 2273.

APPENDIX F
MAINTENANCE PROGRAM AND SAMPLE PRODUCTS

TABLE OF CONTENTS

EQUIPMENT CODE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER (PAGE 1 OF 6)

AGREEMENT NO ________ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION ______________________ BUILDING NAME ______________________ BUILDING CODE __

| | F | TASK | X | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONDENSER<br>INSPECT TUBES | A | 002 | | | | | | | | | | | | | |
| BRUSH TUBES | *A | 003 | | | | | | | | | | | | | |
| ~~ACID CLEAN TUBES~~ | ~~*A~~ | ~~004~~ | | | | | | | | | | | | | N/A |
| LUBRICATION SYSTEM<br>CHANGE OIL | *A | 010 | | | | | | | | | | | | | |
| CHANGE OIL FILTER | *A | 011 | | | | | | | | | | | | | |
| CHECK IMMERSION OIL HEATER | A | 012 | | | | | | | | | | | | | |
| ADJUST IMMERSION HEATER | *A | 013 | | | | | | | | | | | | | |
| TEST OPERATION OF OIL PUMP | A | 014 | | | | | | | | | | | | | |
| PURGE - DEHYDRATOR<br>CHECK CAPACITY | A | 020 | | | | | | | | | | | | | |

X JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly;

M=Monthly; X - Indicates extra tasks to be printed on monthly task lists

* - Extras on CPM III



(Updated 10-29-92)

EQUIPMEN. ODE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER (PAGE 2 OF 6)

AGREEMENT NO ______ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION ______________ BUILDING NAME ______________ BUILDING CODE __

| | F | TASK | X | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURGE - DEHYDRATOR<br>TEST OPERATING AND SAFETY CONTROLS | A | 021 | | | | | | | | | | | | | |
| OVERHAUL AS REQUIRED | *A | 022 | | | | | | | | | | | | | |
| CHANGE FILTER DRYER | *Q | 023 | | | | | | | | | | | | | |
| MOTOR<br>TEST MOTOR WINDING<br>INSULATION RESISTANCE | A | 030 | | | | | | | | | | | | | |
| STARTER<br>TIGHTEN ALL ELECTRICAL CONNECTIONS | *A | 040 | | | | | | | | | | | | | |
| CHECK OIL LEVEL IN<br>OVERLOAD DASH POTS | A | 041 | | | | | | | | | | | | | |
| CHECK STARTER CONTACTORS | A | 042 | | | | | | | | | | | | | |

X JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly;

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* - Extras on CPM III



(Updated 10-29-92)

EQUIPMENT CODE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER

AGREEMENT NO ________ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION ____________ BUILDING NAME ____________ BUILDING CODE __

| | F | TASK | X | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STARTER<br>CLEAN STARTER CONTACTORS | *A | 043 | | | | | | | | | | | | | |
| CHECK FOR PROPER SEQUENCE OF OPERATION OF STARTER MOUNTED CONTROLS | A | 044 | | | | | | | | | | | | | |
| VERIFY PROPER OVERLOAD PROTECTION | U | 045 | | | | | | | | | | | | | |
| CONTROL PANEL<br>TIGHTEN ALL ELECTRICAL CONNECTIONS | *A | 050 | | | | | | | | | | | | | |
| VERIFY PROPER OPERATION AND SETTINGS OF ALL OPERATING AND SAFETY DEVICES | A | 051 | | | | | | | | | | | | | |
| TEST ALL TEMPERATURE AND PRESSURE INDICATORS | A | 052 | | | | | | | | | | | | | |

X JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly;

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(Updated 10-29-92)

EQUIPMENT CODE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER



AGREEMENT NO ________ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION ______________________ BUILDING NAME ______________________ BUILDING CODE __

| | F | TASK | X | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL PANEL<br>ADJUST ALL TEMPERATURE AND<br>PRESSURE INDICATORS | *A | 053 | | | | | | | | | | | | | |
| TEST ALL INDICATOR LIGHTS | A | 054 | | | | | | | | | | | | | |
| OPERATIONAL INSPECTION<br>REVIEW CUSTOMER DIFFICULTIES<br>AND QUESTIONS | Q | 070 | | | | | | | | | | | | | |
| LOG ALL OPERATING TEMPERATURES<br>AND PRESSURES | Q | 071 | | | | | | | | | | | | | |
| CHECK AND ADJUST CRITICAL<br>OPERATING AND SAFETY CONTROLS | *Q | 072 | | | | | | | | | | | | | |
| | | | X | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly;

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(Updated 10-29-92)

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EQUIPMENT JDE: 050 EQUIPMENT TYPE: CENTRIFUGAL CHILLER

AGREEMENT NO ________ EQUIPMENT ID: FROM _____ TO _____ COVERAGE CODE _____ SITE CODE _____

DESCRIPTION ______________________ BUILDING NAME ______________________ BUILDING CODE __

| | F | TASK | X | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ~~OPERATIONAL INSPECTION PERFORM VIBRATION ANALYSIS ON APPLICABLE BEARINGS, DRIVES, MOTORS AND COMPRESSORS. RECORD AND COMPARE RESULTS TO PREVIOUS READINGS. REPORT SIGNIFICANT VARIANCES.~~ | ~~*A~~ | ~~073~~ | | | | | | | | | | | | | |
| OBTAIN OIL SAMPLE | *A | 074 | | | | | | | | | | | | | |
| GENERAL MAINTENANCE CHANGE REFRIGERANT FILTERS | *A | 100 | | | | | | | | | | | | | |
| REFRIGERANT LEAK TEST | A | 101 | | | | | | | | | | | | | |
| REPLENISH REFRIGERANT LEVEL | *A | 102 | | | | | | | | | | | | | |
| CLEAN, SCRAPE, AND PAINT RUST SPOTS AS REQUIRED | *A | 103 | | | | | | | | | | | | | |

N/A

X JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

F-Minimum Frequency Codes: U=Start Up; D=Shut Down; A=Annual; S=Semi-annual; Q=Quarterly; B=Bi-monthly;

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(Updated 10-29-92)

DAILY CH[illegible] G

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UNIT MODEL | TRANE | | | | | | | | | | | | | | | | | | | | | |
| LOCATION | 1029 | | | | | | | | | | | | | | | | | | | | | |
| SYSTEM NUMBER | | | | | | | | | | | | | | | | | | | | | | |
| RECORDED BY | cw | w | cw | cw | cw | ev | [illegible] | CL | cw | BB | C | cw | [illegible] | cw | cw | cw | cw | joe | w | w | Joe | joe |
| MONTH DATE | 8/1 | 9/6 | 9/7 | 9/8 | 9/13 | 9/15 | 9/27 | 9/28 | 10/3 | 10/4 | 10/5 | 10/6 | 10/10 | 10/11 | 10/12 | 10/13 | 10/14 | 10/18 | 10/19 | 10/20 | 10/23 | 10/24 |
| MOTOR AMPS | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| OIL LEVEL | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | OK | OK | ok | OK | OK |
| OIL PRESSURE | 12/140 | 12/144 | 12/143 | 12/144 | 11/141 | 11/144 | 12/146 | 12/145 | 10/142 | 10/142 | 11/142 | 11/144 | 10/147 | 10/144 | 10/145 | 11/144 | 10/140 | 10/143 | 10/142 | 10/144 | 10/144 | 13/140 |
| EVAPORATOR PRESSURE | -8.3 | -8.2 | -8.3 | -8.1 | 8.2 | -8.2 | 8.1 | -8.2 | 8.2 | 8.3 | 8.0 | 8.1 | -8.2 | -8.1 | -8.3 | -8.1 | -8.1 | 8.1 | 8.2 | -8.0 | 8.2 | 7.8 |
| REFRIGERANT TEMPERATURE | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | OK | OK | ok | ok | OK |
| ENTERING CHILL WATER | 49 | 47 | 48 | 48 | 48 | 47 | 47 | 47 | 46 | 44 | 44 | 45 | 46 | 46 | 48 | 46 | 45 | 45 | 47 | 46 | 46 | 40 |
| LEAVING CHILL WATER | 44 | 44 | 44 | 44 | 45 | 44 | 44 | 44 | 44 | 43 | 43 | 44 | 43 | 43 | 43 | 43 | 44 | 44 | 44 | 44 | 44 | 42 |
| REFRIGERANT LEVEL | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | ok | OK | ok | ok | ok | OK |
| CONDENDER PRESSURE | .8 | .7 | 1.3 | 2.3 | .3 | .5 | 1.9 | .1 | .6 | .3 | .7 | .4 | .2 | .1 | .6 | .7 | 1.3 | .9 | .4 | .2 | .2 | .2 |
| REFRIGERANT TEMPERATURE | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | | |
| CONDENSER WATER INLET TEMPERATURE | 81 | 82 | 62 | 86 | 41 | 82 | 86 | 80 | 78 | 80 | 80 | 84 | 84 | 83 | 82 | 80 | 76 | 79 | 80 | 81 | 80 | 76 |
| CONDENSER WATER OUTLET TEMPERATURE | 85 | 86 | 86 | 90 | 84 | 85 | 88 | 83 | 80 | 82 | 83 | 83 | 82 | 81 | 87 | 82 | 78 | 81 | 82 | 82 | 62 | 77 |
| CONDENSER PUMP DISCHARGE PRESSURE | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / |
| CHILL WATER DISCHARGE PUMP | / | / | / | / | / | / | / | / | / | / | / | / | / | / | / | | / | / | / | / | / | / |
| A TEMP | 75 | 76 | 77 | 72 | 75 | 74 | 75 | 74 | 70 | 70 | 64 | 66 | 74 | 60 | 65 | 68 | 60 | 55 | 72 | 50 | 82 | 62 |
| APPROCH Temp EVAP | 2. | | | | | | | | | | | | | | | 2.0 | 1.3 | 1.7 | 2.1 | 1.2 | 2.3 | 1.4 |
| COND | | | | | | | | | | | | | | | | 1.3 | .5 | 1.0 | 1.2 | .7 | 1.2 | .0 |

NOTE: ALL REFRIGERANT TEMPERATURES FROM TEMPERATURE PRESSURE CHART

SERVICES PROVIDED BY CALGON CORPORATION

COOLING TOWERS, CONDENSERS, BOILERS AND CLOSED LOOPS

1. Calgon will supply one full time account Manager in San Antonio with 24 years of water treatment experience and fifteen years of experience on Ft. Sam Houston.

2. Calgon will supply one full time Service Technician dedicated to Ft. Sam Houston for fulfilling the water treatment contract obligations. The technician has over seven years of experience on Ft. Sam Houston equipment.

3. Calgon will supply the Service Technician with a pickup truck, fitted with a lift gate, for transporting water treatment chemicals to each of the locations specified.

4. Calgon will have available two other Service Technicians, located in the San Antonio area, that are designated as back-up if assistance is required.

5. Calgon will visit each individual cooling and boiler system one time a week or as many time as needed to accomplish the task.

6. A complete water analysis; condenser, cooling tower and boiler report on each system weekly to include;

COOLING WATER ANALYSIS REPORT

A. Chloride test in ppm
B. Alkalinity test in ppm
C. Conductivity test in micromhos
D. TDS in ppm
E. pH
F. Product residual
G. Cycles of concentration

CONDENSER REPORT

A. Condenser pressure
B. Condenser water temperatures
C. Delta T
D. Delta P (actual and design)
E. Amperage reading

COOLING TOWER REPORT

A. Inspect fill
B. Inspect sump
C. Inspect distribution decks
D. Inspect float valve
E. Fan and by-pass operation
F. Water level
G. Water meter reading
H. Any other condition that may effect the operation of the cooling tower and condenser and closed loop system.

BOILER WATER ANALYSIS REPORT

A. Neutralized Conductivity
B. Total Dissolved Solids
C. Hydroxide Alkalinity
D. Sulfite
E. Phosphate
F. pH

CONDENSATE

A. pH
B. Total Dissolved Solids

MAKE UP

A. Hardness
B. Total Dissolved Solids
C. Water Meter Reading

7. Monitor, calibrate and adjust all control equipment for the water treatment program.
   A. Conductivity meter
   B. Chemical feed pumps
   C. Sample lines
   D. Blowdown valves

8. Replacement of the cooling tower float valves when necessary. (labor only)

9. Adjustment of the balancing valves on the distribution decks of the cooling towers when necessary.

10. Keep the distribution decks and nozzles clean of mud, silt and foreign debris.

11. Delivery of all water treatment chemicals to each of the individual locations as needed.

12. Maintain an on going inventory of chemicals at each location where water treatment is required.

13. Disposal of all empty or used containers used in the water treatment program.

14. Chemical cleaning of condensers and cooling towers if it is a direct result of water treatment problems.

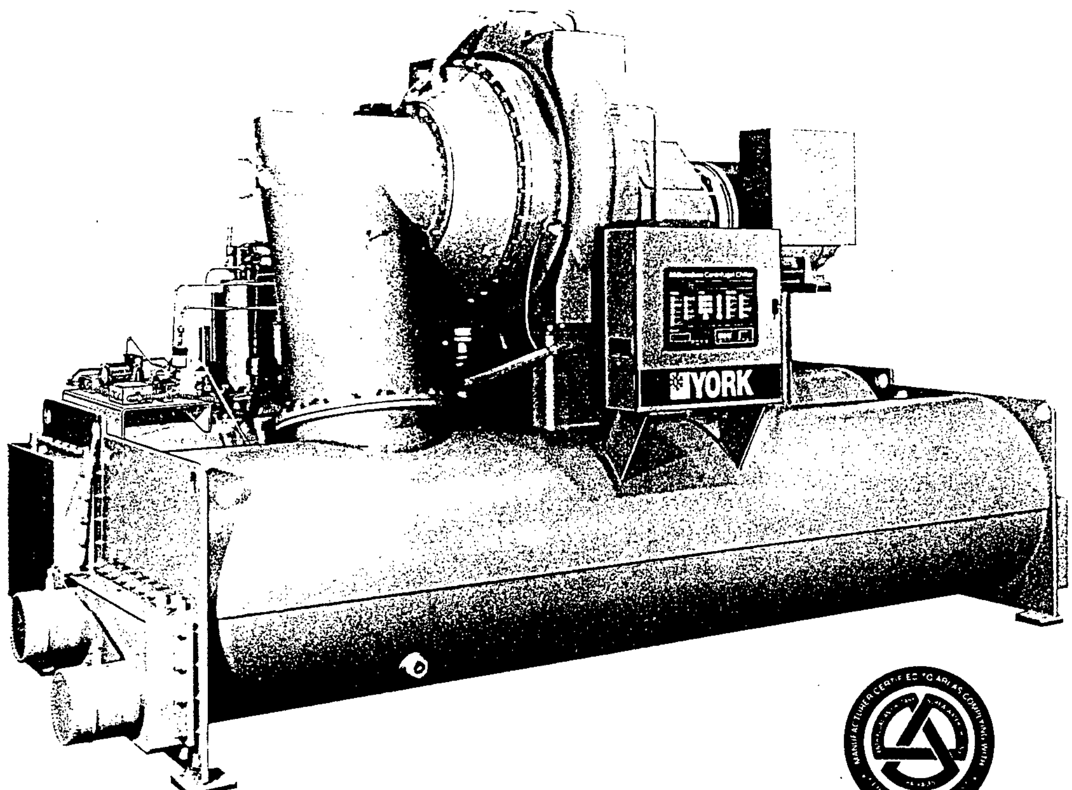
15. Complete analytical lab for detailed water analysis if necessary, Ie. closed loop system contaminates.

16. The weekly cooling system water analysis will be done locally so that there can be an immediate response to systems that may be out of adjustment.

FORM 160.48-EG1 (196)

# YORK®

## *MILLENNIUM*™ Centrifugal Liquid Chillers




Rated In Accordance with
ARI Standard 550-92

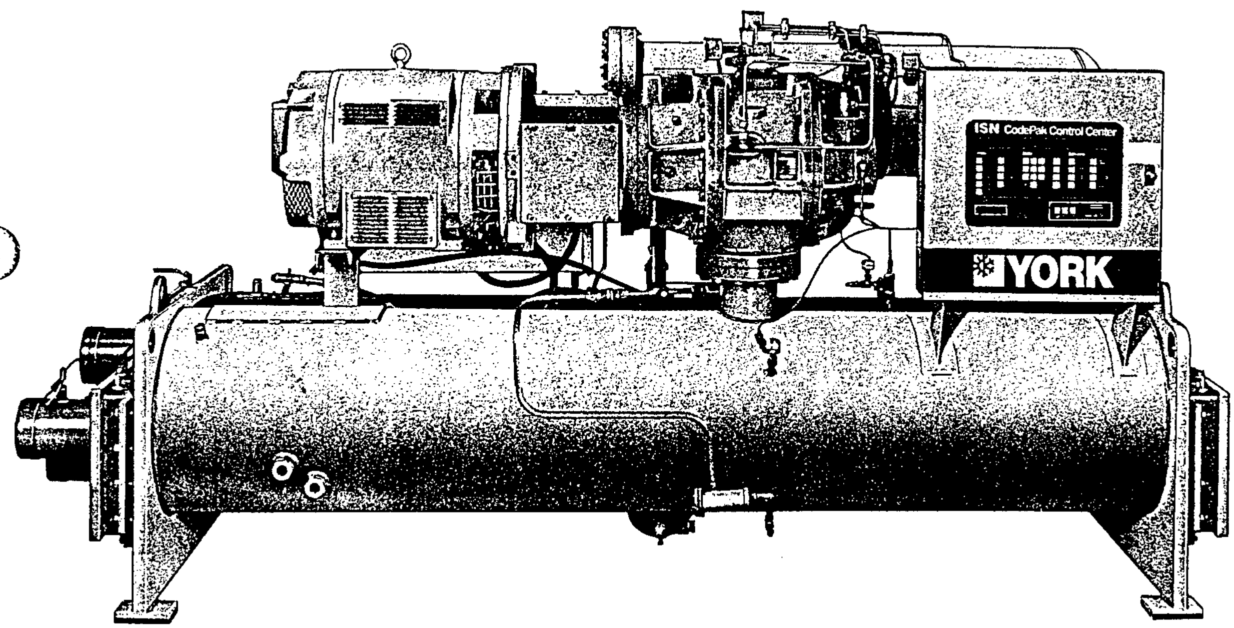
MODEL YT
150 THROUGH 850 TONS
HCFC - 123

FORM 160.47-EG1 (193)

# YORK®

# CodePak™

## Rotary Screw Liquid Chillers

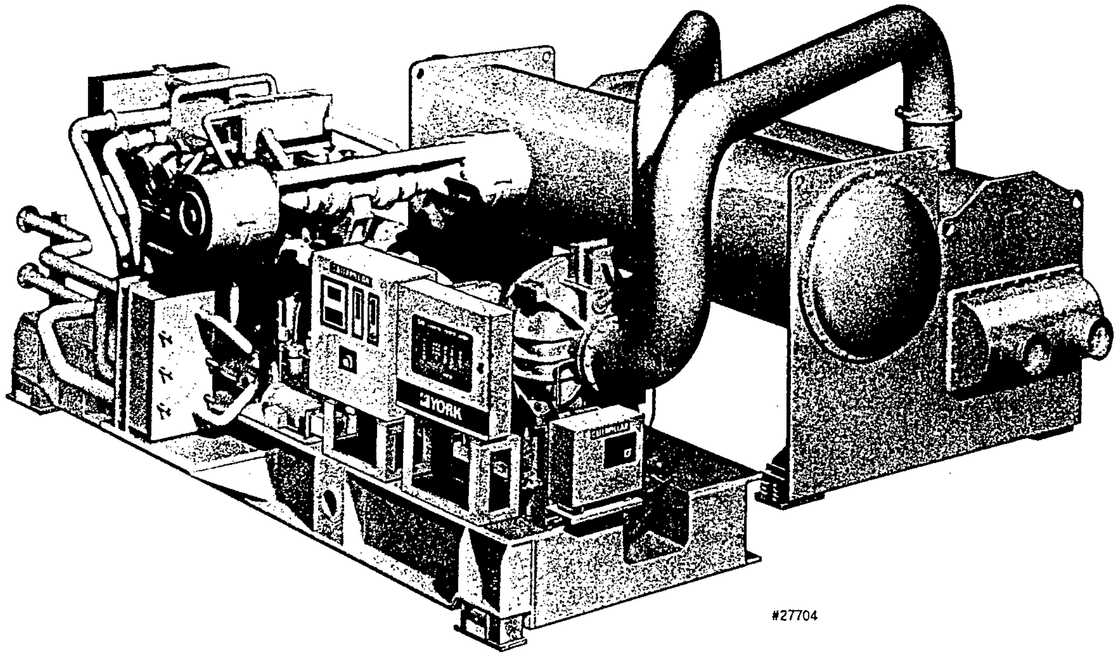



## 125 through 675 tons

FORM 160.60-EG1 (1295)

YORK®

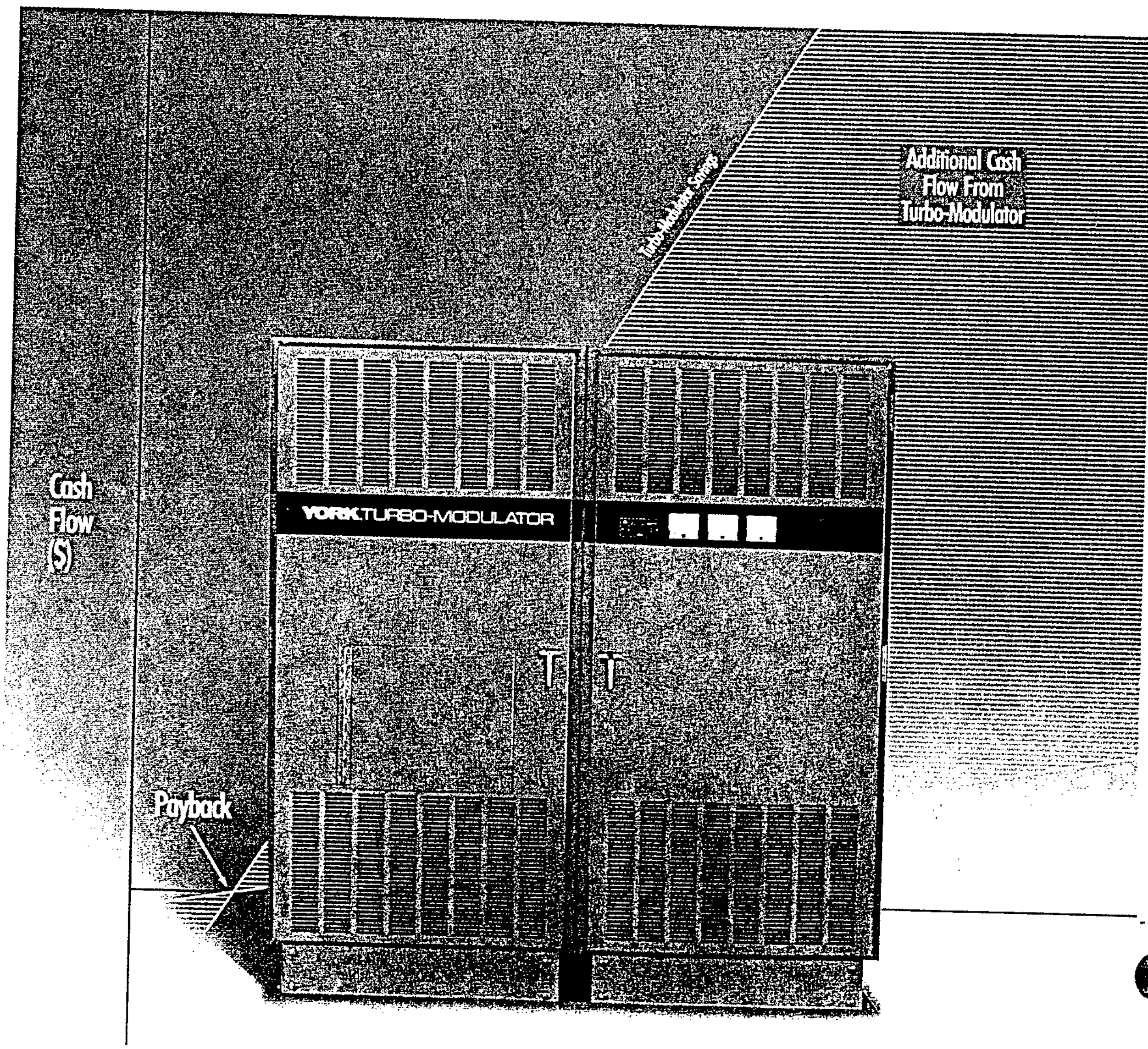
# MILLENNIUM™
# GAS-ENGINE-DRIVE CHILLERS
## Design Level "A"



#27704

## 400 Through 2100 Tons
## Utilizing HFC-134a

# Greater payback potential—at a lower first cost.



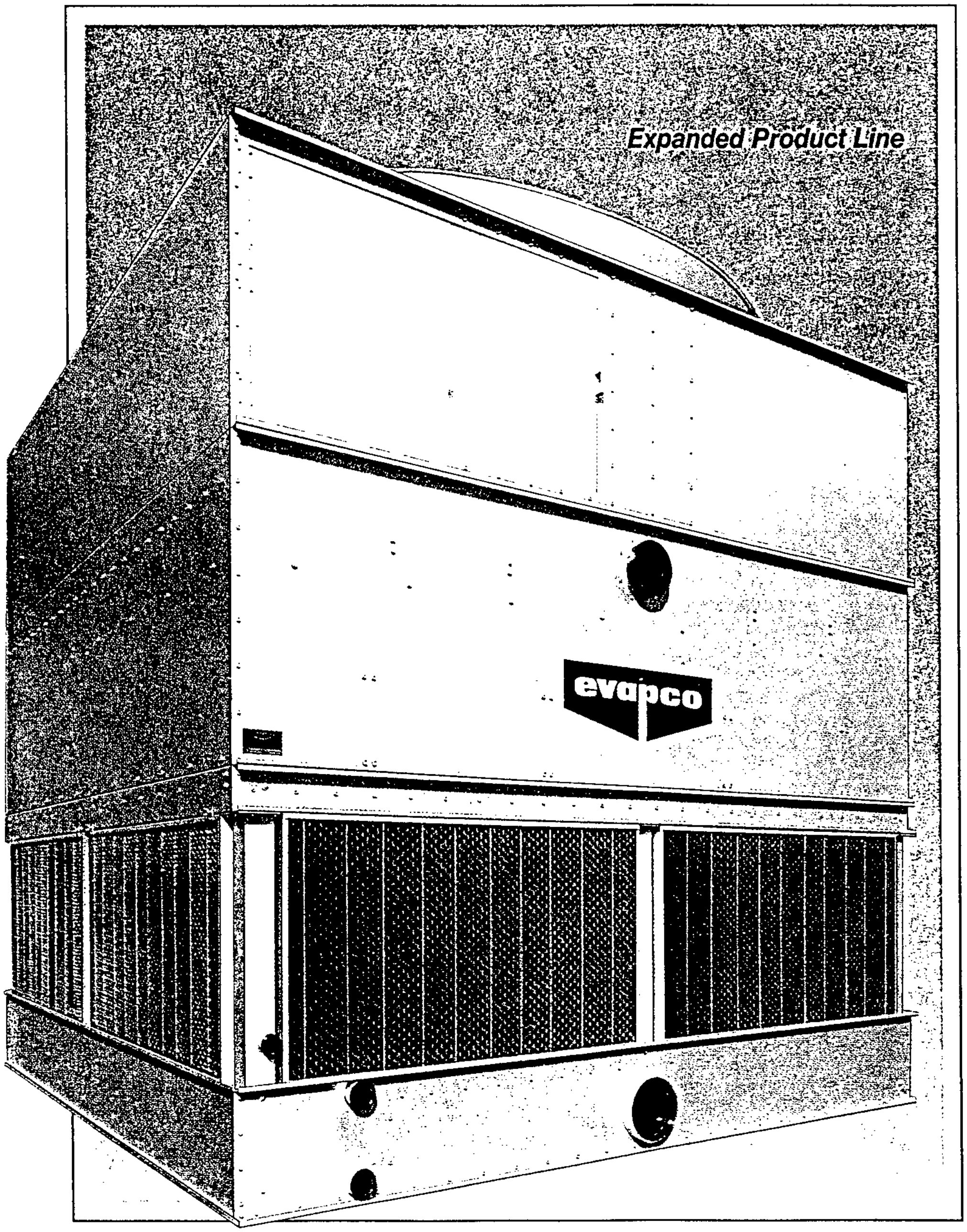
# AT-Line Cooling Towers

evapco

Advanced Features In
Induced Draft, Counterflow Towers

Member A.R.I.
Air Conditioning and Refrigeration Institute

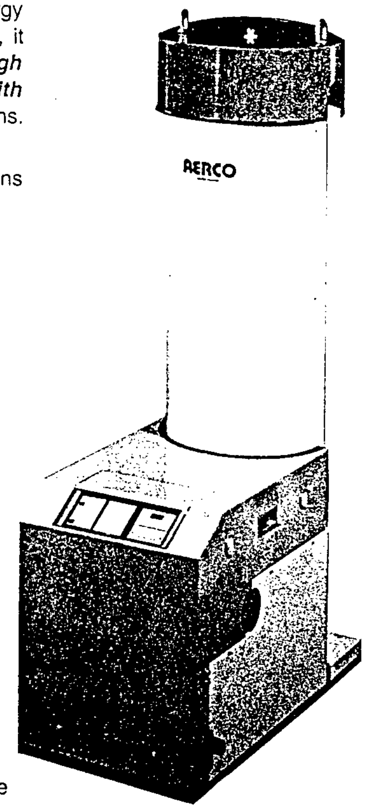
Member C.T.I.
Cooling Tower Institute



AERCO

# MODEL KC-1000 GWB
TECHNICAL DATA

## AERCO KC Gas Fired Hot Water Boiler System




The AERCO KC Water Boiler is a true industry advance that meets the needs of today's energy and environmental concerns. Designed for application in any closed loop hydronic system, it relates energy input directly to fluctuating system load, yielding ***seasonal efficiencies as high as 95%.*** The boiler can be used singly or in ***modular arrangements for inherent standby with minimum space requirements.*** Venting flexibility permits installation without normal restrictions.

The advanced electronics of each boiler module offer selectable modes of operation. The options available include:

Constant Temperature Internal Setpoint
Indoor/Outdoor Reset
4-20ma Linear Signal Response
AERCO Boiler Management System Integration
AERCO Combination Domestic Water/Boiler Plant

Regardless of the mode of operation, the load tracking capability of every unit delivers the ultimate in energy control through energy input modulation with a 14:1 ratio while meeting all load demands.

With condensing capability, the KC Boiler is ideally suited for modern low temperature as well as conventional heating systems. Because of the compact design with direct or conventional venting, the KC Boiler system is applicable to either new construction or retrofit application with the same excellent results. Efficiently, reliability, and longevity make the KC Boiler System a true step forward in heating system design.

### KC1000 FEATURES

- Natural Gas or Propane
- 14:1 Turndown Ratio
- Direct Vent or Conventional Vent Capabilities
- ASME 150 PSIG Working Pressure Certified
- UL, ULC Listed, FM Approved, ASME Coded
- UL, ULC Listed for Alcove Installation on Combustible Flooring
- Quiet Operation throughout Firing Range
- Internal Low Water Cutoff and Dual Over Temperature Protection
- Compact Space Efficient Design
- Precise Temperature Control +/– 2F
- Optional Sealed Combustion

### KC-1000 Specifications

| | |
|---|---|
| BTU Input | 1,000,000 BTU/Hr† |
| Net Output @ full input | 860,000–915,000 BTU/Hp* |
| ASME Working Pressure | 150 PSIG |
| Electrical Requirement | 120/1/60 20 Amp |
| Gas Requirements | 8.5" W.C. Minimum @Full Load<br>14" W.C. Maximum |
| Vent Size | 6" Diameter |
| Water Connections | 4" Flanged 150 lb. ANSI |
| Gas Connection | 1-1/4" NPT |
| Minimum Water Flow | 25 GPM |
| Maximum Water Flow | 150 GPM |
| Water Pressure Drop | 0.23 Ft. 100 GPM |
| Water Volume | 23 Gallons |
| Control Range | 50F to 220F |
| Standard Listings & Approvals | UL, ULC, FM, ASME |
| Optional Approval | IRI |
| Weight, Installed | 1200 lbs. |

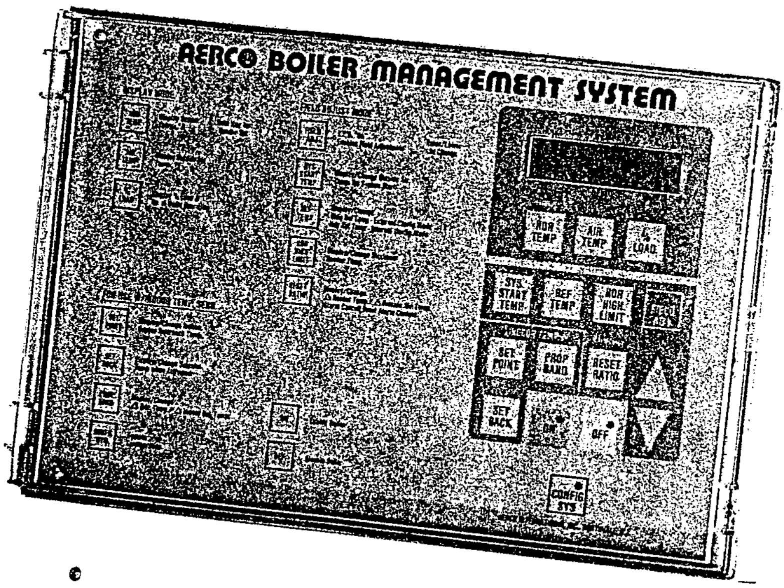
*Output is dependent upon return water temp. and firing rate—see efficiency curves on reverse.

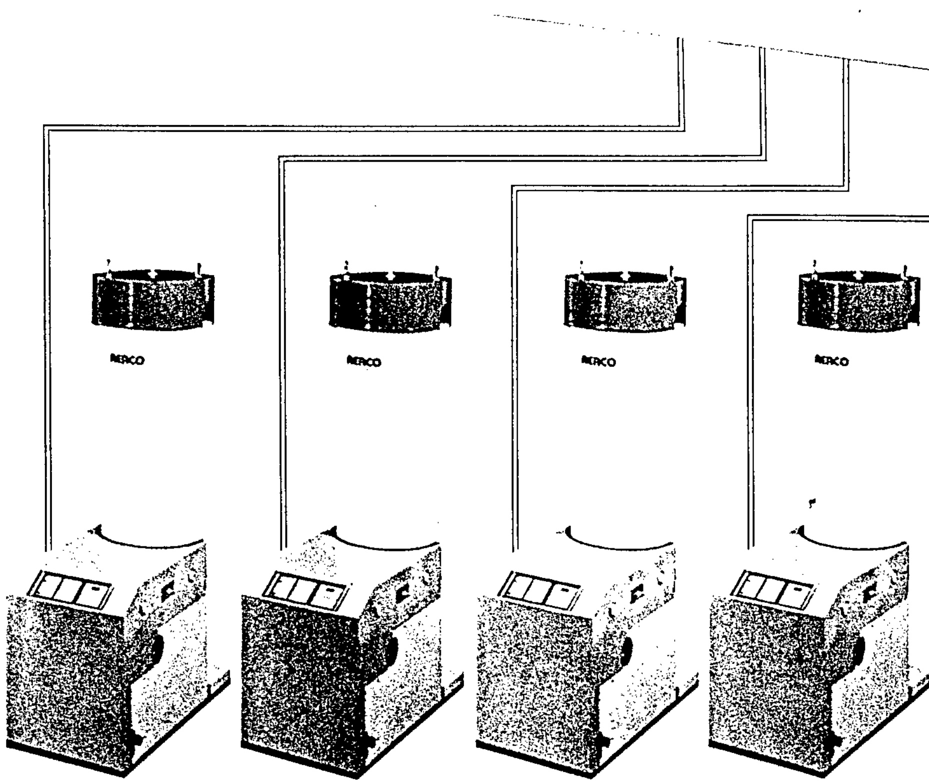
†Up to 2000 Altitude.

Factory Mutual System

# AERCO Boiler Management System

- Powerful Main Mode Selections
- Powerful Internal Programmable Software
- Completely Operator Controlled & Responsive
- Full Information LCD Display
- Controls up to Eight KC Series Boilers

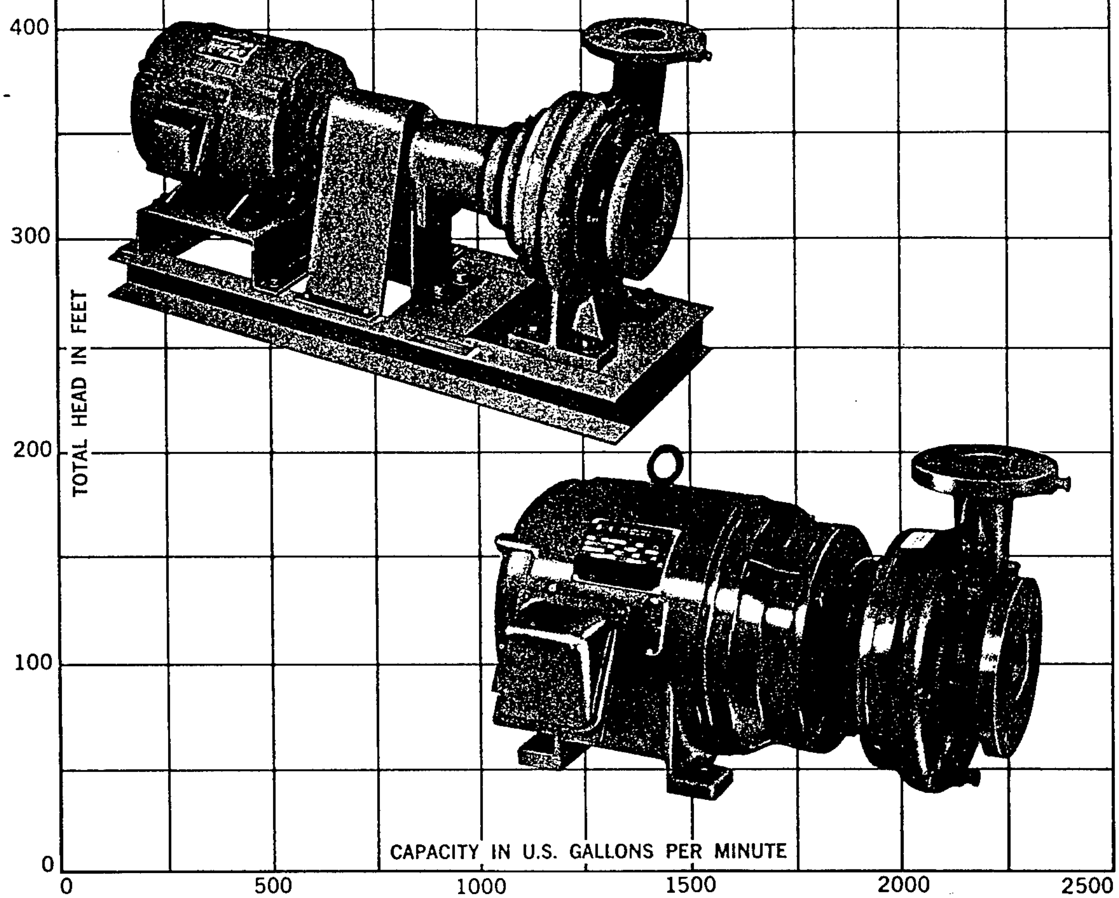


- "Bumpless" Energy Transfer
- Maximizes Efficiency of KC Boile Modules
- Easy Installation & Automatic Operation
- Complete Control of Auxiliary Equipment

**BELL & GOSSETT**

Bulletin B-207D




# SERIES 1510/1531

# Centrifugal Pumps

## Applications

- Hydronic Heating & Cooling Systems
- Industrial
- Pressure Boosting
- General Pumping Requirements

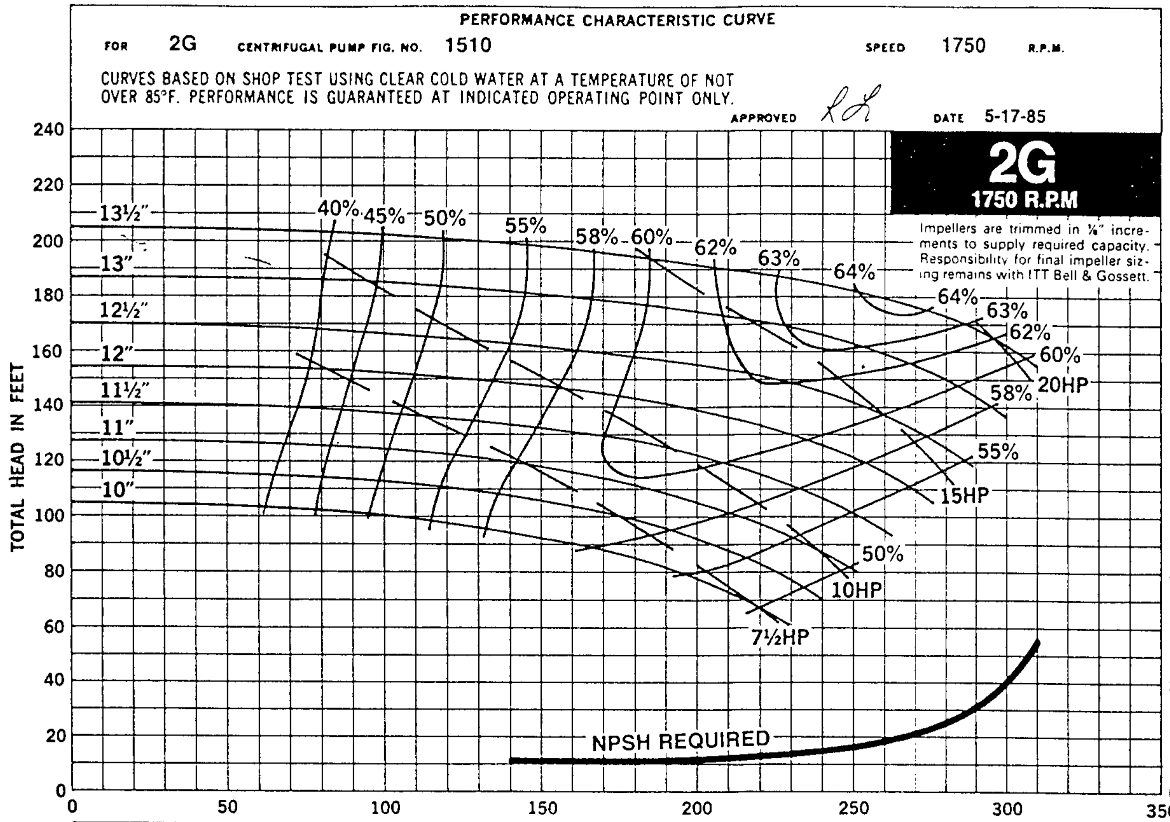
## Advantages

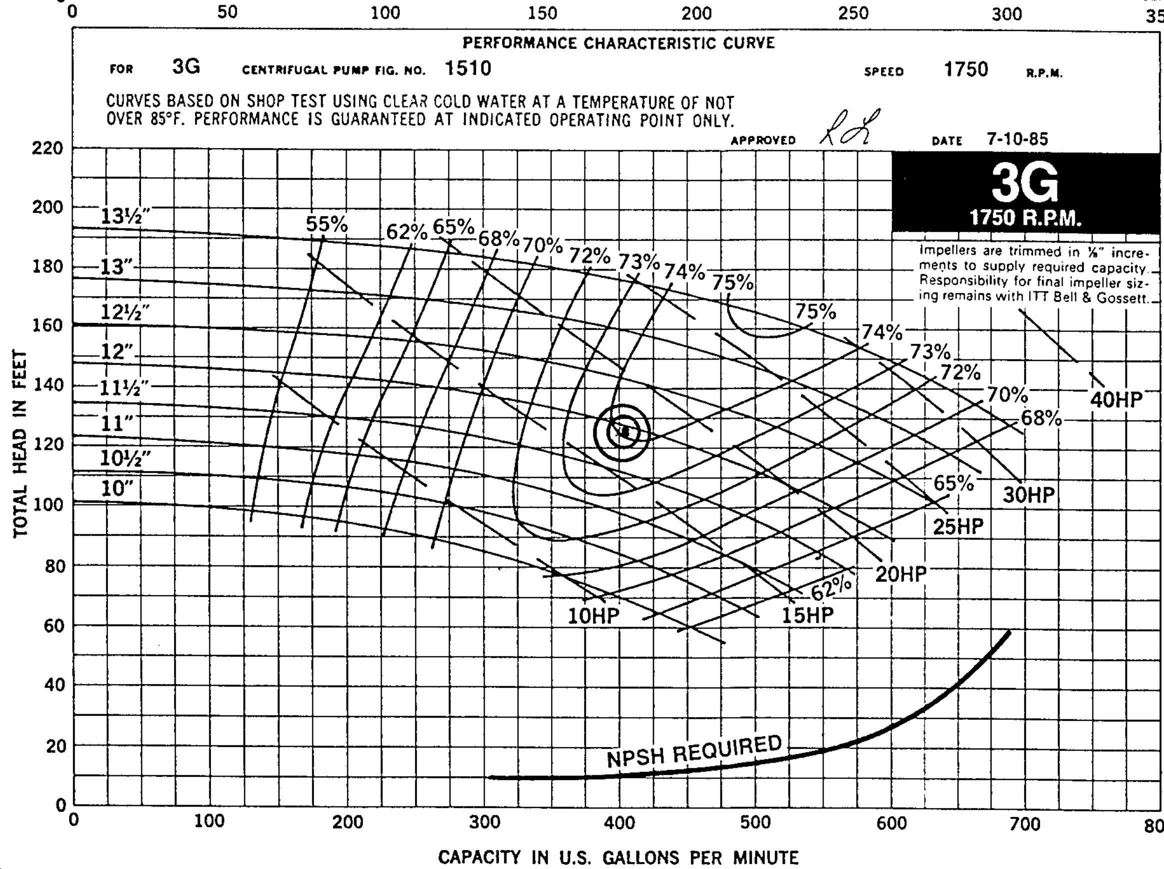
- High Efficiency Low Operating Costs
- Modern Designs
- Easy Maintenance
- Several Seal Options
- Broad Range of Application

Part of the ESP Equipment Selection Program

ITT Bell & Gossett
ITT Fluid Technology Corporation

# 1750 RPM PUMP CURVES



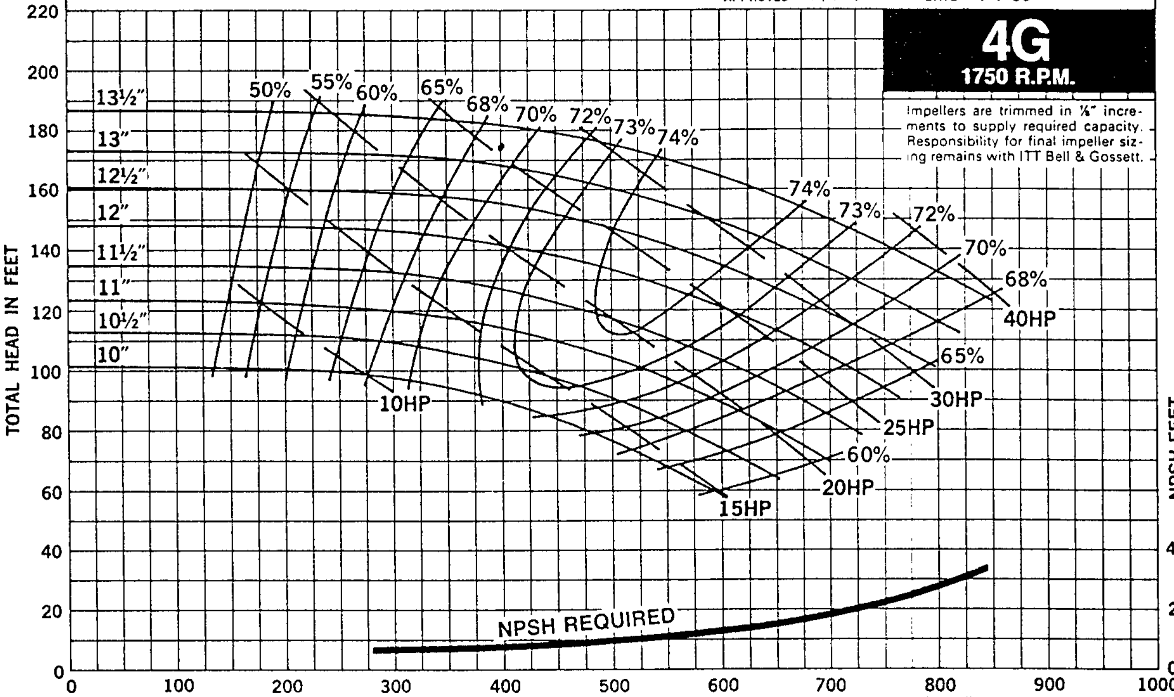
# 1750 RPM PUMP CURVES

PERFORMANCE CHARACTERISTIC CURVE

FOR 4G CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED DATE 7-7-85

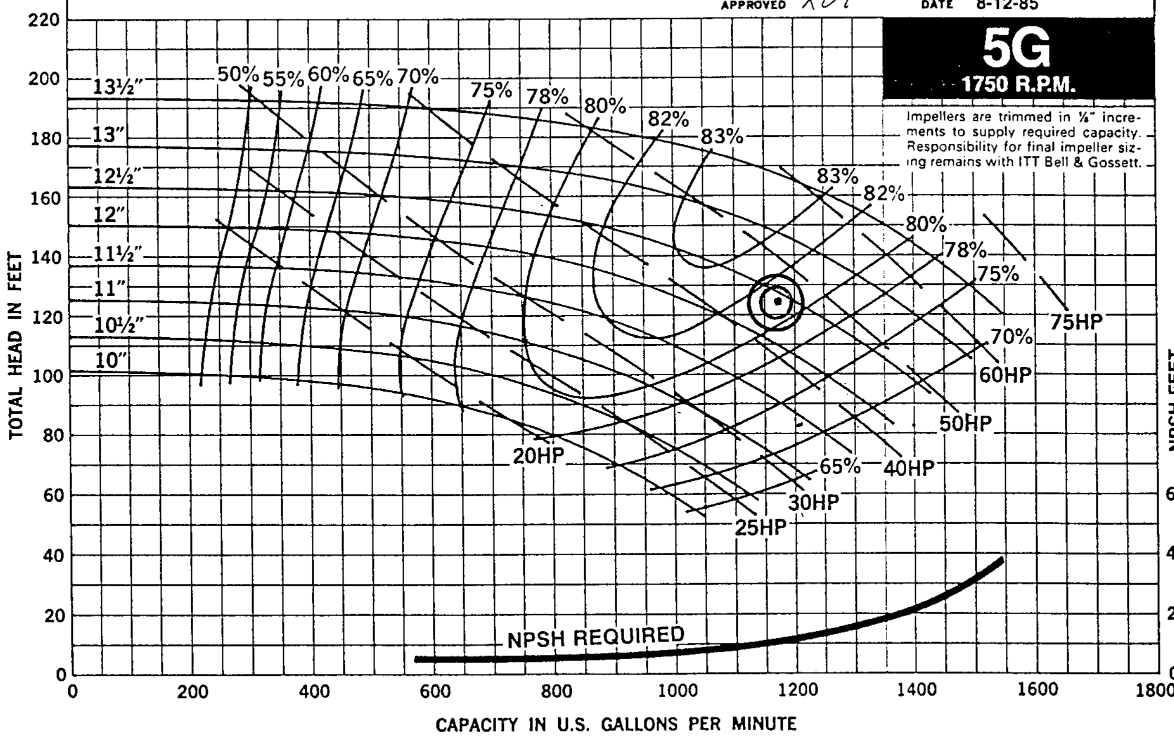



PERFORMANCE CHARACTERISTIC CURVE

FOR 5G CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED DATE 8-12-85



# 1750 RPM PUMP CURVES

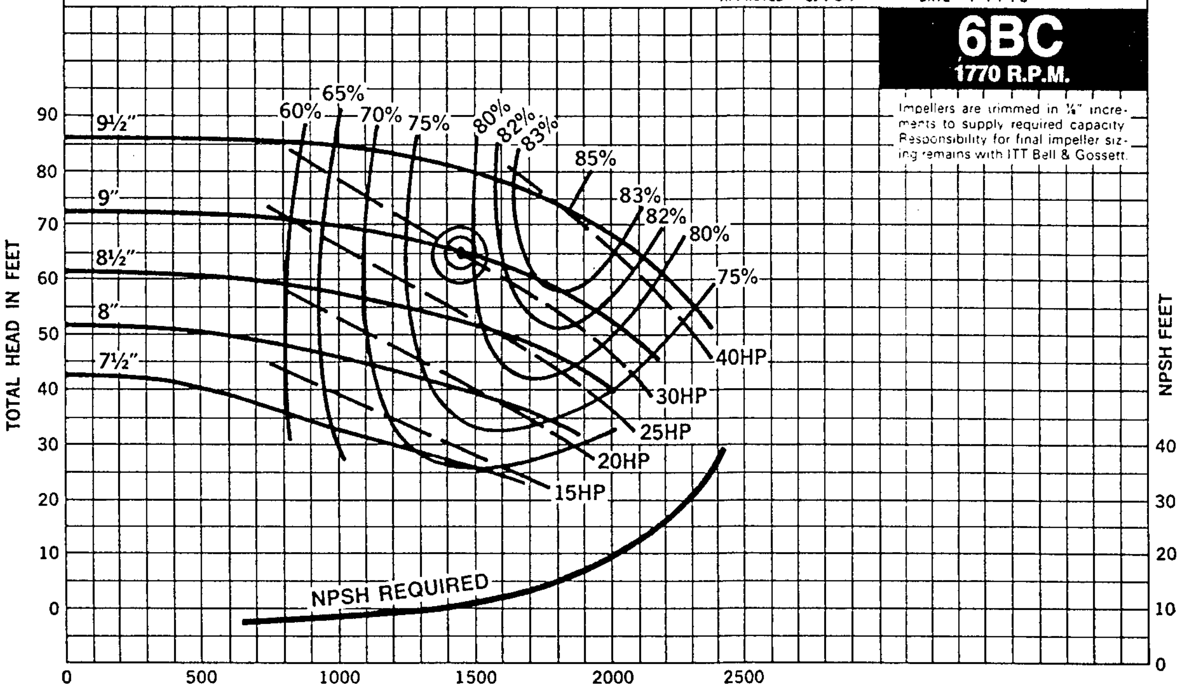


PERFORMANCE CHARACTERISTIC CURVE

FOR 6BC CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1770 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED R.B. DATE 7-14-78

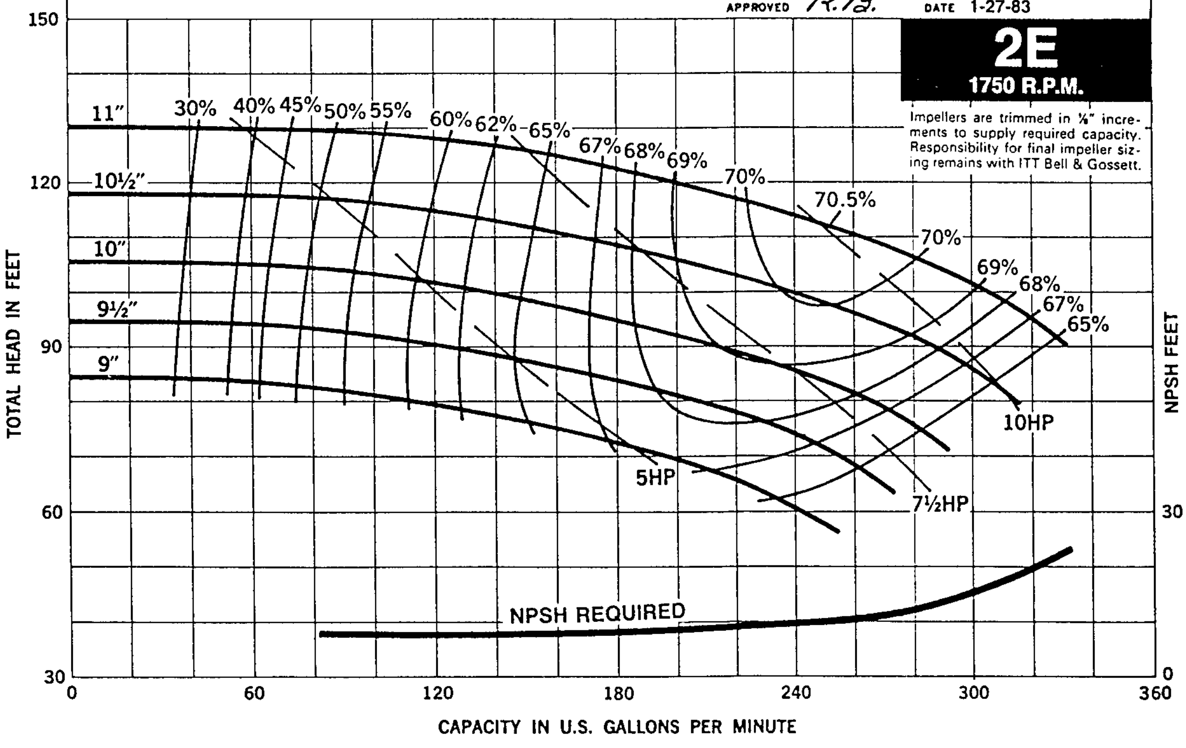



PERFORMANCE CHARACTERISTIC CURVE

FOR 2E CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED R.B. DATE 1-27-83



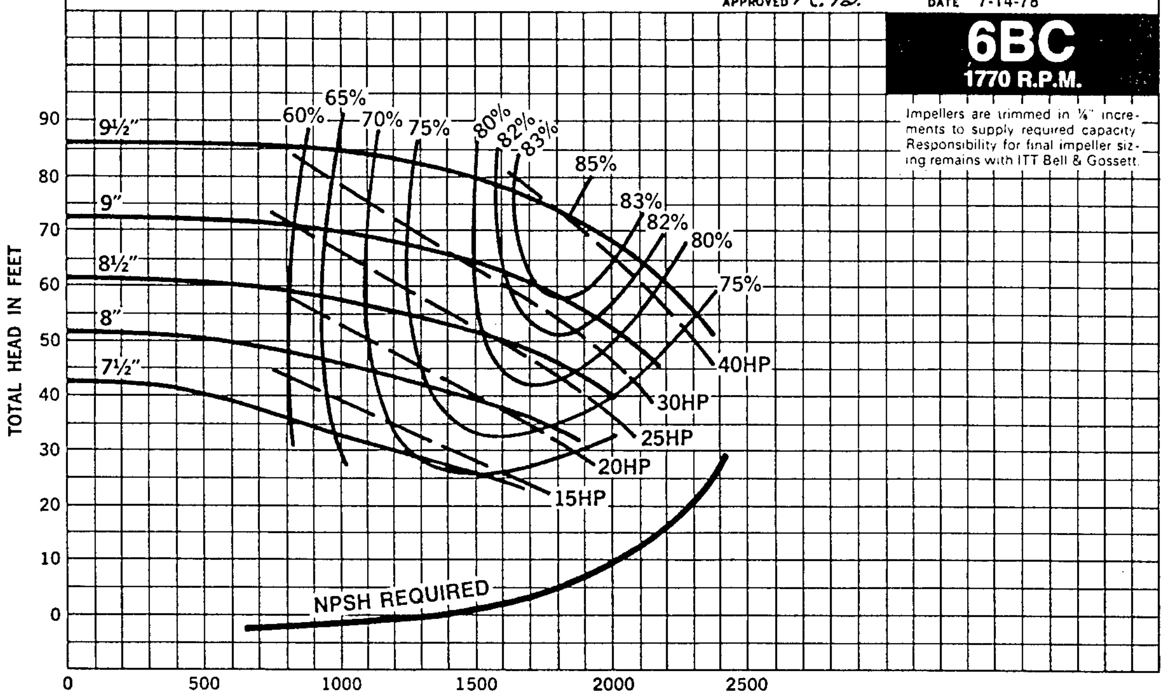
# 1750 RPM PUMP CURVES

PERFORMANCE CHARACTERISTIC CURVE

FOR 6BC CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1770 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

APPROVED R.B. DATE 7-14-78




PERFORMANCE CHARACTERISTIC CURVE

FOR 2E CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

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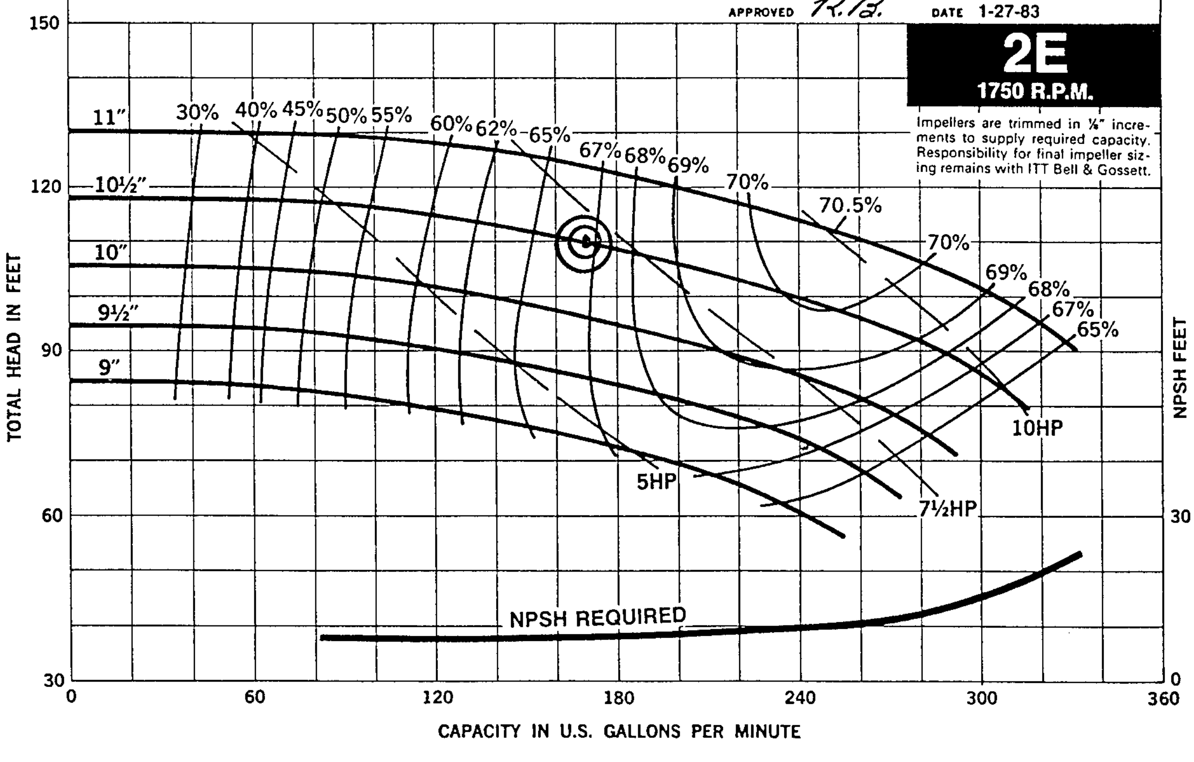

# 1750 RPM PUMP CURVES

PERFORMANCE CHARACTERISTIC CURVE

FOR 6BC CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1770 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

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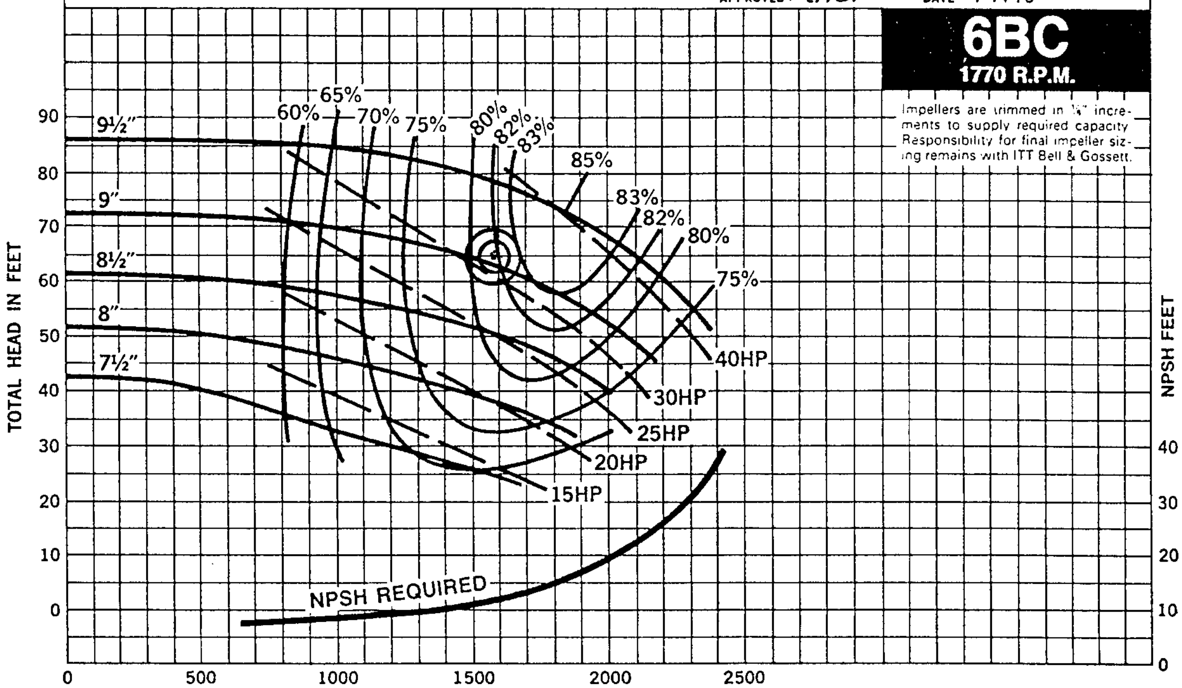
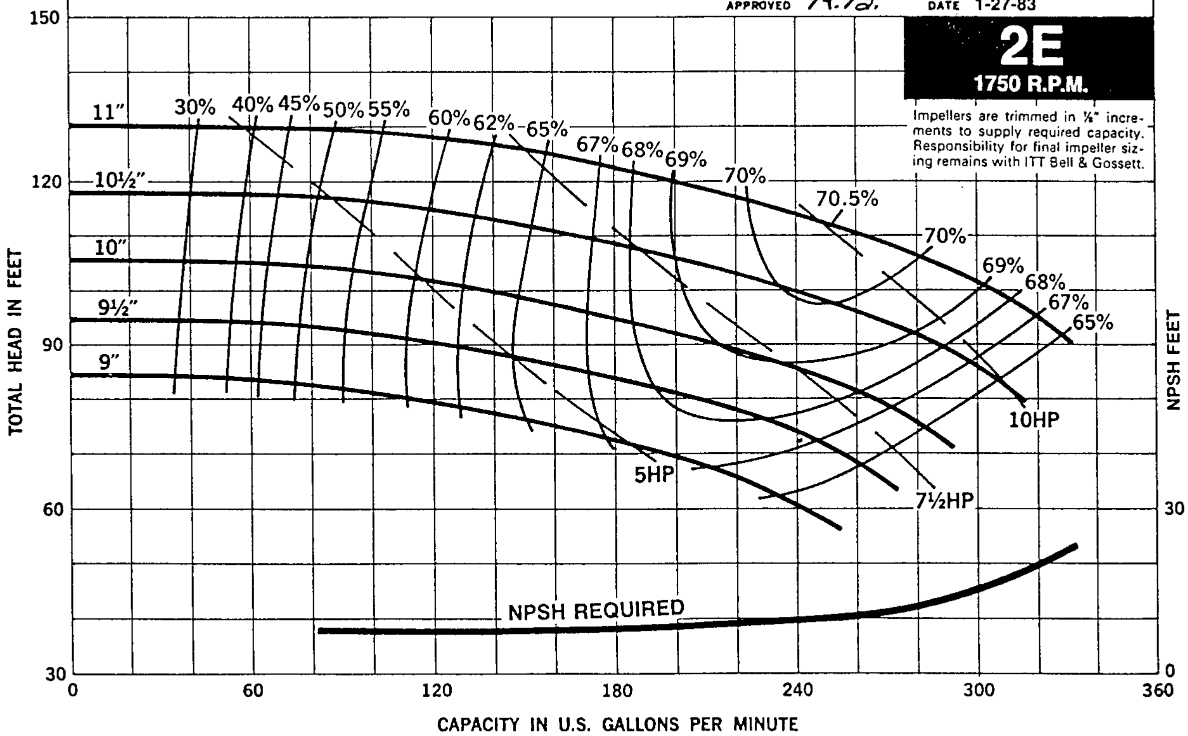



PERFORMANCE CHARACTERISTIC CURVE

FOR 2E CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY.

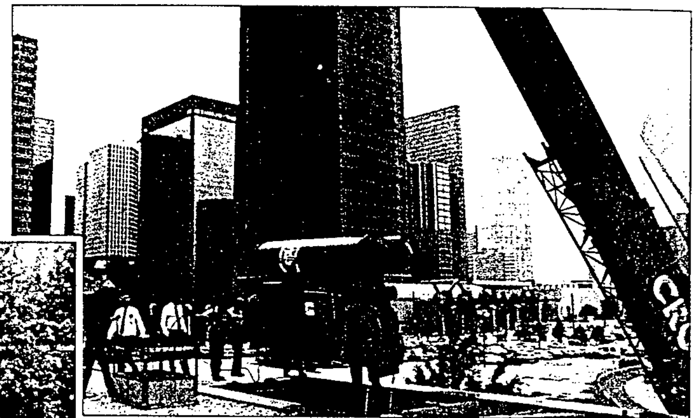
APPROVED R.B. DATE 1-27-83

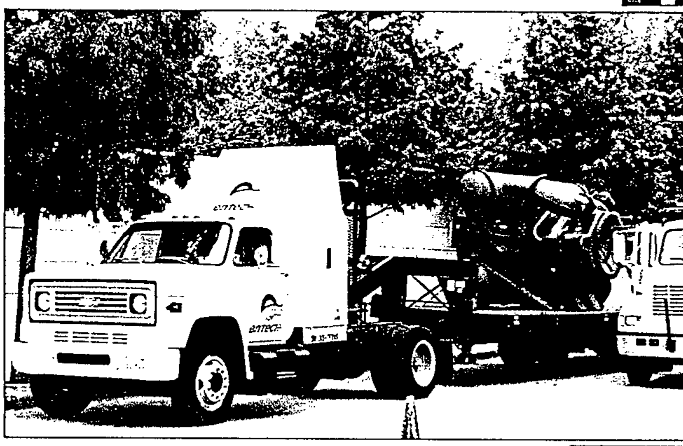


entech
SALES & SERVICE, INC.

# CHILLERS
## COOLING SOLUTIONS

SALES





SERVICE

RENTALS

TRAINING

## LARGE INVENTORY

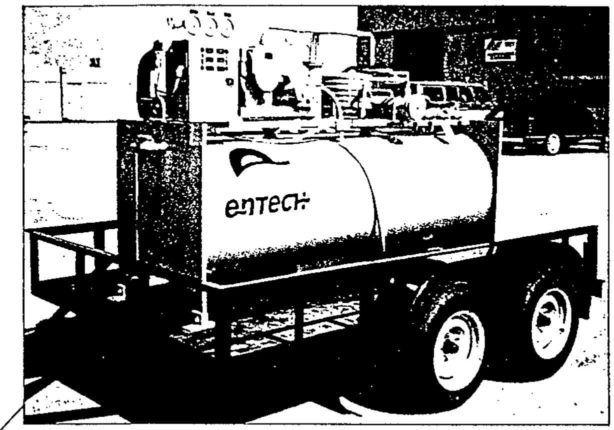
- Water Cooled Chillers
- Air Cooled Chillers
- Cooling Towers

## WE BUY EQUIPMENT

# REBUILT CHILLERS FOR SALE

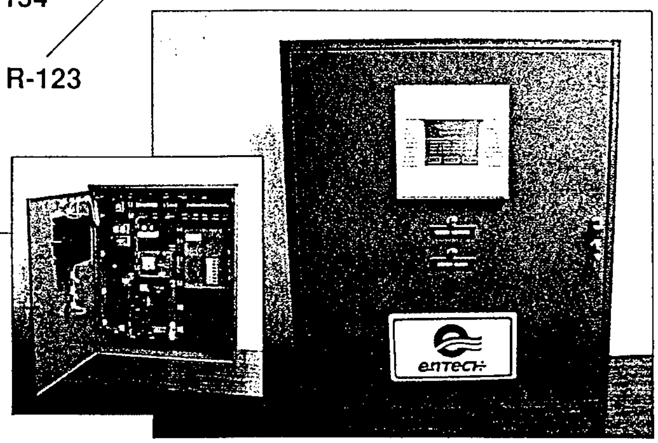
- Over 10,000 tons of Water Cooled Chillers. Sizes range from 15 tons to over 500 tons
- Air Cooled Chillers from 20 tons to 320 tons
- Cooling Towers from 100 tons to 600 tons

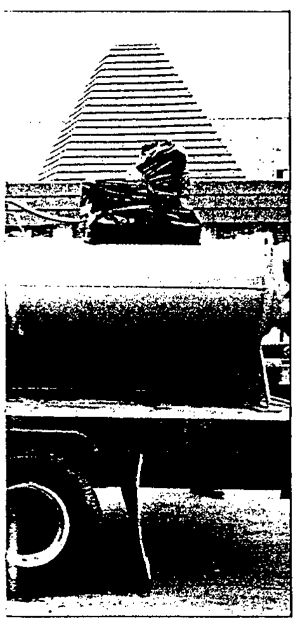
Entech Will Convert Chillers For The New Acceptable Refrigerants – R-123 and R-134

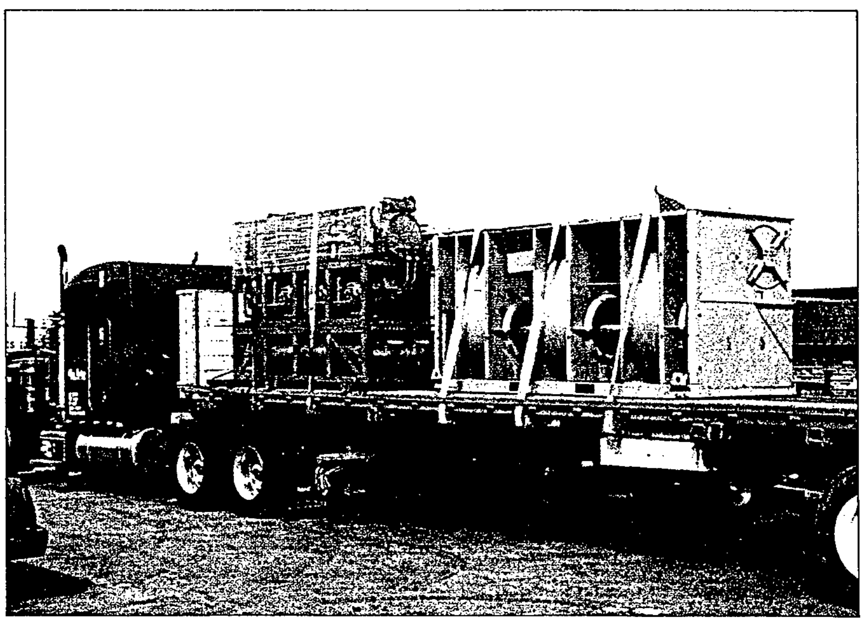



Refrigerant Recovery Units for R-11 and R-123 Refrigerants

Chiller Plant Monitors For Monitoring Refrigerant Loss.

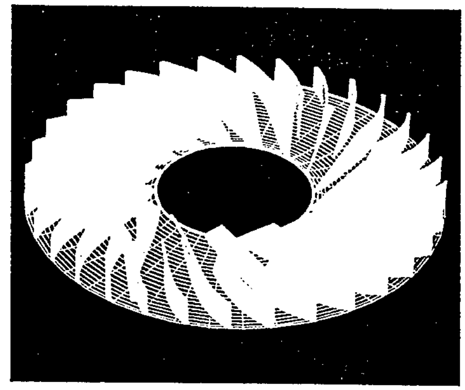


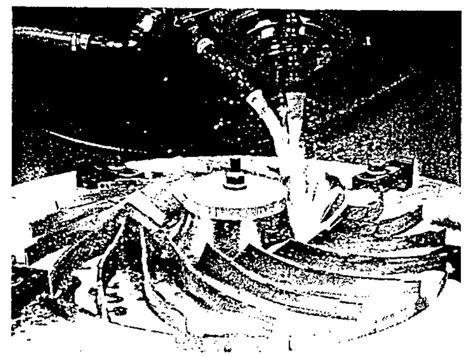


# Centrifugal Chiller Conversions

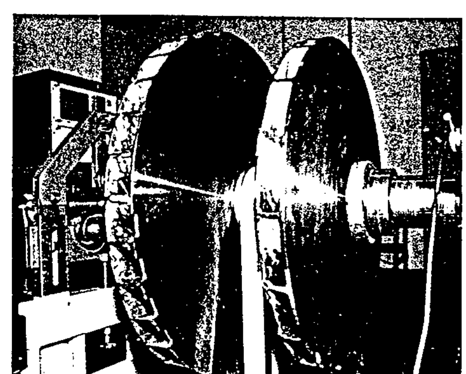
NREC uses high-performance impellers to convert centrifugal chillers from CFCs to environmentally safer refrigerants with no loss in cooling capacity.



- Replace CFC refrigerants
- Maintain cooling capacity
- Improve power consumption
- Avoid new equipment costs
- Minimize installation costs
- Reduce impact on operations



**Companies using CFC refrigerants in centrifugal chiller systems must face the phase out and elimination of CFCs.** Simply substituting a new refrigerant in an existing unit will typically result in a 5% to 30% loss in cooling capacity and up to a 20% increase in power consumption. The only practical solutions to this problem are to modify or replace these chiller units. For most installations, modifying a chiller to use alternative refrigerants is far less expensive than replacing the machine.



*NORTHERN RESEARCH
AND ENGINEERING CORPORATION*

NREC

39 Olympia Avenue · Woburn, MA 01801-2073 USA
Telephone: (617) 935-9050 · Telefax: (617) 935-9052
Telex: 466928 NOR RES WOB. UD

June 16, 1995

Mr. John Carter
Huitt-Zollars
512 Main Street, Suite 1500
Forth Worth, TX 76102

Dear Mr. Carter:

We are pleased to provide our Preliminary and Budgetary Quotation No. 950-2361 describing the design and manufacture of replacement impellers for returning original capacity to various chillers described in your fax of June 14, 1995.

Based on our past experience, we believe that any capacity loss resulting from the conversion from CFC-11 refrigerant to HCFC-123 can be rectified by changing the impellers. This option will retain original operating conditions, including driving speed, and will avoid the need to change other system components such as the condenser. This presumes that the evaporator and condenser are adequately sized for the added HCFC-123 flow rates.

NREC proposes to design and supply new compressor impellers which will provide the pressure ratios and flow rates required by the use of the new refrigerant. NREC predicts that the present capacity of the systems using CFC-11 can be achieved using our high performance impellers with negligible increases in power consumption. However, we reserve the possibility of up to a 5 percent increase in power consumption.

This proposal assumes that we will work with a contractor of Huitt-Zollars's choice to perform the entire conversion of the machines for the customer. NREC will be responsible for:

- measuring compressor internals,
- designing and fabricating new impellers,
- balancing the impellers,
- supporting the contractor during the installation, conversion, completion, and operational testing of the converted system.

The selected contractor would be responsible for:

- removing and reinstalling the impeller,
- providing all other on-site support and conversion tasks.

NREC will retain overall responsibility for the satisfaction of the performance requirements. The impellers will be designed and manufactured to operate within the

specified original equipment. The impellers will be individually balanced, spin-tested, and assembled to the original rotor shaft.

Listed below are the preliminary and budgetary prices for the chillers you outlined in your request:

| | | | | |
|---|---|---|---|---|
| Area: | 900 | 2200 | 1300 | 1350 |
| Manufacturer: | York | Chrysler | Trane | Carrier |
| Make: | TurboPak HT | Airtemp | Centravac | |
| Model: | YTC3D3C1CJC | C2MN7792 | PCV5FC1D1 | 19DK7894CP |
| Quantity: | One (1) | One (1) | Two (2) | One (1) |
| Budget Price: | $175,000 | $250,000 | $275,000 | $35,000 |

Since NREC have not yet designed impellers for the specific York, Chrysler, and Trane compressors above, a significant non-recurring engineering and tooling effort is included in the budget price. NREC is currently evaluating market potentials and, within six months, may develop a design and production plan for the York TurboPak and Trane Centravac chillers. This new position could possibly reduce the costs for the replacement TurboPak and Centravac impellers.

This proposal is subject to the standard "Products Sales" Terms and Conditions of our parent company, Ingersoll-Rand. A copy of these Terms and Conditions is attached. If you have any questions about the quotation, please feel free to contact me at (617) 937-4668 or Mel Mittnick, Senior Applications Engineer, at (617) 937-4655.

Sincerely,

NORTHERN RESEARCH AND ENGINEERING
CORPORATION

C. Jimmy Tang

Chi-Wu (Jimmy) Tang
Sales Engineer

CJT/ph
Enclosure

2361HUIT.DOC

# TERMS AND CONDITIONS
## Products

### 1. GENERAL

The Terms and Conditions of Sale outlined herein shall apply to the sale by Ingersoll-Rand Company (hereinafter referred to as Company) of products, equipment and parts relating thereto (hereinafter referred to as Equipment). Unless prior written agreement is reached, it shall be understood that the Company's proceeding with any work shall be in accordance with the terms and conditions outlined herein.

The Company will comply with applicable laws and regulations in effect on the date of the Company's proposal as they may apply to the manufacture of the Equipment. Compliance with any local government laws or regulations relating to the location, use, or operation of the Equipment, or its use in conjunction with other equipment, shall be the sole responsibility of the Purchaser.

### 2. TITLE AND RISK OF LOSS

Title and risk of loss or damage to the Equipment shall pass to the Purchaser upon tender of delivery F.O.B. manufacturing facility unless otherwise agreed upon by the parties, except that a security interest in the Equipment shall remain in the Company, regardless of mode of attachment to realty or other property, until full payment has been made therefore. Purchaser agrees upon request to do all things and acts necessary to perfect and maintain said security interest and shall protect Company's interest by adequately insuring the Equipment against loss or damage from any cause wherein the Company shall be named as an additional insured.

### 3. ASSIGNMENT

Neither party shall assign or transfer this contract without the prior written consent of the other party. The Company however shall be permitted to assign or transfer, without the prior written consent of the Purchaser, the Company's right to receive all or any portion of the payment due from the Purchaser under this contract.

### 4. DELIVERY AND DELAYS

Delivery dates shall be interpreted as estimated and in no event shall dates be construed as falling within the meaning of "time is of the essence".

The Company shall not be liable for any loss or delay due to war, riots, fire, flood, strikes or other labor difficulty, acts of civil or military authority including governmental laws, order, priorities or regulations, acts of the Purchaser, embargo, car shortage, damage or delay in transportation, inability to obtain necessary labor or materials from usual sources, faulty forgings or castings, or other causes beyond the reasonable control of the Company. In the event of delay in performance due to any such cause, the date of delivery or time for completion will be adjusted to reflect the actual length of time lost by reason of such delay. The Purchaser's receipt of Equipment shall constitute a waiver of any claims for delay.

### 5. TAXES

The price does not include any present or future Federal, State, or local property, license, privilege, sales, use excise, gross receipts or other like taxes or assessments which may be applicable to, measured by, imposed upon or result from this transaction or any services performed in connection therewith. Such taxes will be itemized separately to Purchaser, who shall make prompt payment to the Company. The Company will accept a valid exemption certificate from Purchaser, if applicable. If such exemption certificate is not recognized by the governmental taxing authority involved, Purchaser agrees to promptly reimburse the Company for any taxes covered by such exemption certificate which the Company is required to pay.

### 6. SET OFFS

Neither Purchaser nor any affiliated company or assignee shall have the right to claim compensation or to set off against any amounts which become payable to the Company under this contract or otherwise.

### 7. PATENTS

The Company shall defend any suit or proceeding brought against the Purchaser and shall pay any adverse judgment entered therein so far as such suit or proceeding is based upon a claim that the use of the Equipment manufactured by the Company, and furnished under this contract constitutes infringement of any patent of the United States of America, providing the Company is promptly notified in writing and given authority, information and assistance for defense of same; and the Company shall, at its option, procure for the Purchaser the right to continue to use said Equipment, or to modify it so that it becomes non-infringing, or to replace the same with non-infringing equipment, or to remove said Equipment and to refund the purchase price. The foregoing shall not be construed to include any agreement by the Company to accept any liability whatsoever in respect to patents for inventions including more than the Equipment furnished hereunder, or in respect of patents for methods and processes to be carried out with the aid of said Equipment. The foregoing states the entire liability of the Company with regard to patent infringement.

## 8. WARRANTY

The Company warrants that the Equipment manufactured by it and delivered hereunder will be free of defects in material and workmanship for a period of twelve months from the date of placing the Equipment in operation or eighteen months from the date of shipment, whichever shall first occur. The Purchaser shall be obligated to promptly report any failure to conform to this warranty, in writing to the Company within said period, whereupon the Company shall, at its option, correct such nonconformity by suitable repair to such Equipment or, furnish a replacement part F.O.B. point of shipment, provided the Purchaser has stored, installed, maintained and operated such Equipment in accordance with good industry practices and has complied with specific recommendations of the Company. Accessories or equipment furnished by the Company, but manufactured by others, shall carry whatever warranty the manufacturers have conveyed to the Company and which can be passed on to the Purchaser. The Company shall not be liable for any repairs, replacements, or adjustments to the Equipment or any costs of labor performed by the Purchaser or others without the Company's prior written approval.

The effects of corrosion, erosion and normal wear and tear are specifically excluded. Performance warranties are limited to those specifically stated within the Company's proposal. Unless responsibility for meeting such performance warranties are limited to specified shop or field tests, the Company's obligation shall be to correct in the manner and for the period of time provided above.

THE COMPANY MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

Correction by the Company of nonconformities whether patent or latent, in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of the Company for such nonconformities, whether based on contract, warranty, negligence, indemnity, strict liability or otherwise with respect to or arising out of such Equipment.

The Purchaser shall not operate Equipment which is considered to be defective, without first notifying the Company in writing of its intention to do so. Any such use of Equipment will be at the Purchaser's sole risk and liability.

## 9. LIMITATION OF LIABILITY

THE REMEDIES OF THE PURCHASER SET FORTH HEREIN ARE EXCLUSIVE, AND THE TOTAL LIABILITY OF THE COMPANY WITH RESPECT TO THIS CONTRACT OR THE EQUIPMENT AND SERVICES FURNISHED HEREUNDER, IN CONNECTION WITH THE PERFORMANCE OR BREACH THEREOF, OR FROM THE MANUFACTURE, SALE, DELIVERY, INSTALLATION, REPAIR OR TECHNICAL DIRECTION COVERED BY OR FURNISHED UNDER THIS CONTRACT, WHETHER BASED ON CONTRACT, WARRANTY, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE, SHALL NOT EXCEED THE PURCHASE PRICE OF THE UNIT OR EQUIPMENT UPON WHICH SUCH LIABILITY IS BASED.

THE COMPANY AND ITS SUPPLIERS SHALL IN NO EVENT BE LIABLE TO THE PURCHASER, ANY SUCCESSORS IN INTEREST OR ANY BENEFICIARY OR ASSIGNEE OF THIS CONTRACT FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES ARISING OUT OF THIS CONTRACT OR ANY BREACH THEREOF, OR ANY DEFECT IN, OR FAILURE OF, OR MALFUNCTION OF THE EQUIPMENT HEREUNDER, WHETHER BASED UPON LOSS OR USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL, WORK STOPPAGE, IMPAIRMENT OR OTHER GOODS, LOSS BY REASON OF SHUTDOWN OR NON-OPERATION, INCREASED EXPENSES OF OPERATION, COST OF PURCHASE OR REPLACEMENT POWER OR CLAIMS OF PURCHASER OR CUSTOMERS OF PURCHASER FOR SERVICE INTERRUPTION WHETHER OR NOT SUCH LOSS OR DAMAGE IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE.

## 10. NUCLEAR LIABILITY

In the event that the Equipment sold hereunder is to be used in a nuclear facility, the Purchaser shall, prior to such use, arrange for insurance or governmental indemnity protecting the Company against liability and hereby releases and agrees to indemnify the Company and its suppliers for any nuclear damage, including loss of use, in any manner arising out of a nuclear incident, whether alleged to be due, in whole or in part to the negligence or otherwise of the Company or its suppliers.

## 11. GOVERNING LAW

The rights and obligations of the parties shall be governed by the laws of the State of New Jersey excluding any conflicts of law provisions. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this agreement.

## 12. EXECUTION

The Company shall not be bound by any contract or any modification thereto until approved in writing by an officer of the Company. The contract, when so approved shall supersede all previous communications, either oral or written.

APPENDIX G
MAPS, BUILDING, AND EQUIPMENT DATA FORMS

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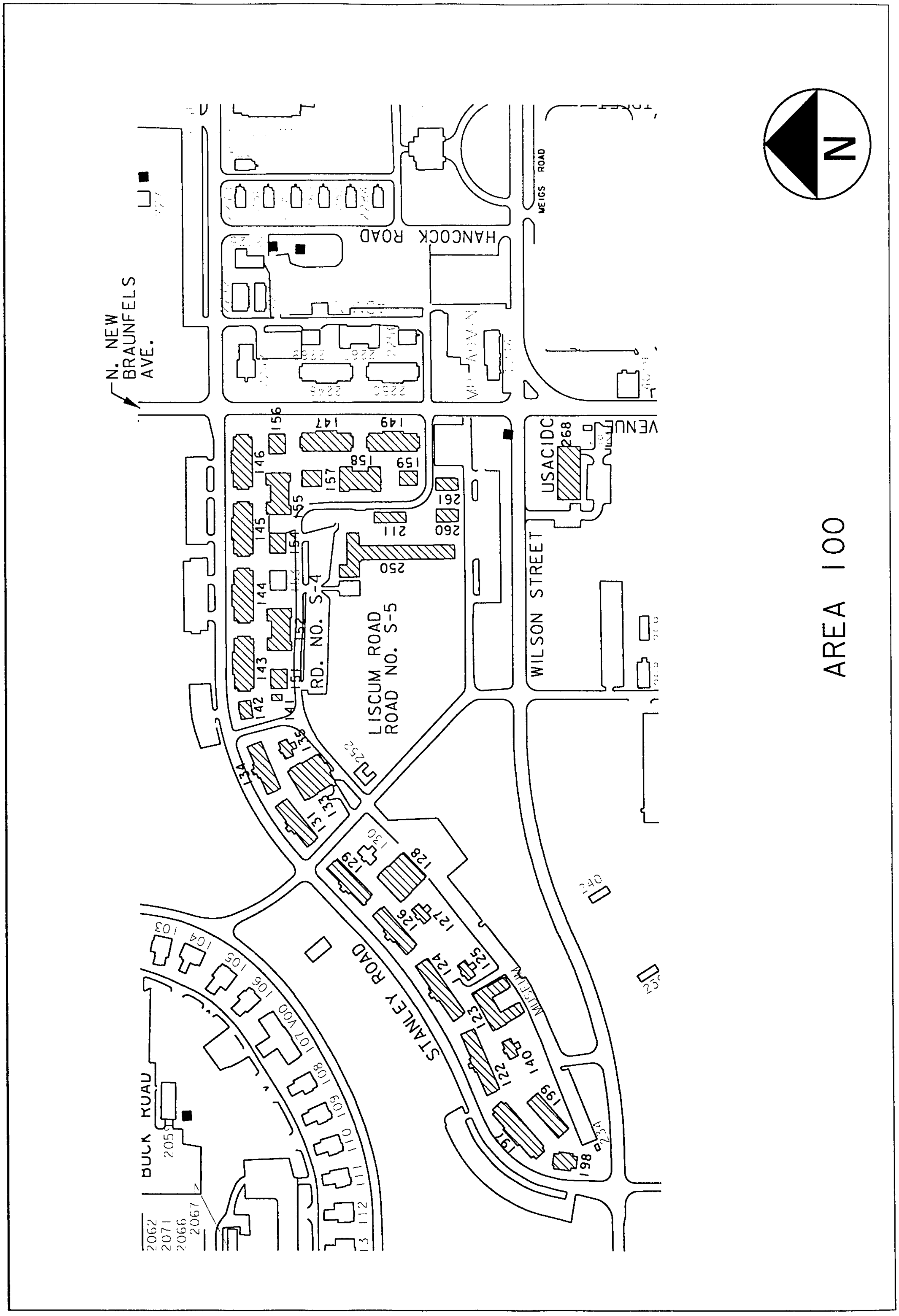

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MEIGS ROAD
LISCUM ROAD
ROAD NO. S-5
RD. NO. S-4
WILSON STREET
STANLEY ROAD
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## BUILDING DESCRIPTION

NAME: Building 123

USE: Fort Sam Houston Museum. Continuous occupancy from Wednesday through Sunday, between 10:00 A.M. and 4:00 P.M. Four full-time staff and 20,000 visitors per year.

GROSS AREA (SQ.FT.): 10,389 STORIES: 1 DATE OF SURVEY: 10/17/95

DATE OF CONSTRUCTION: 1941

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete finish, carpet, and vinyl coated tile

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Five (5) ½ HP, one (1) 3/4 HP water cooled packaged FCU's serve the entire museum. These units are controlled manually by unit mounted switches. Also, fourteen (14) 1/6 HP floor mounted dehumidifiers condition the air and provide spot dehumidification. The six packaged air handlers reject the heat of the space to a condenser water loop that is served by a cooling tower with a 2 HP fan located on the West side of the building. See HVAC Equipment Lists for details.

HEATING EQUIP: Four (4) ceiling mounted, gas fired, unit heaters heat the museum. See HVAC Equipment Lists for details.

LIGHTING: Suspended 2'/4', 2-lamp, fluorescent lay-in fixtures on the first floor and incandescent fixtures in the basement.

DOMESTIC WATER HEATING: One (1) 100 gallon gas fired domestic water heater, and one (1) 50 gallon gas fired domestic water heater in basement were not currently operating.

OTHER: One (1) condenser water pump located with the cooling tower, and one (1) restroom exhaust fan interlocked with the lights. See HVAC Equipment Lists for details.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. The cooling tower fan does not cycle with temperature but runs continuously. One (1) of the packaged air handlers is never operated, and another is operated with the fan only and no cooling. Fiberglass batt insulation is above the 10' clear ceiling space.

## BUILDING DESCRIPTION

NAME: Buildings 122 & 124

USE: Administrative offices - Dir. of Resource Management. Continuous occupancy of approximately 30 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 12,782 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Two (2) 3 HP and one (1) 5 HP four-pipe, multi-zone AHU's with three-way controlled CHW and HW coils serve each building. Units served by ACR located outside each bldg. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. Heating water is provided by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: CHW pump and HW pump for each bldg. See HVAC Equipment Lists for details.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Poor temperature control, very hot inside during the field visit. Building 124 was being renovated at the time of the site visit. All HVAC equipment appeared to be in fair to poor condition, however most controls were not functioning properly.

**BUILDING DESCRIPTION**

NAME: Buildings 126, 129, 131

USE: Administrative offices - Dir. Of Patient admin. Services & Biostat Activities (PASBA), BAMC Info. Mgt. Div. & Visual Info. Med. Informatics, and H.Q. 41st Combat Support Hospital. Continuous occupancy during weekdays, between 7:00 A.M. and 5:00.

GROSS AREA (SQ.FT.): 12,087 STORIES: 2 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete finish in basement, carpet on other floors

CEILINGS: Acoustical tile and plasterboard

WINDOWS: single pane, clear glass

COOLING EQUIP: Bldg. 126 is served by one (1) cooling-only, single zone, 5 HP AHU with three-way controlled chilled water coil, and one (1) ACR chiller outside. The first and second floors of Bldg. 129 are served by two 7.5 HP (2) two-pipe FCU's, and one (1), 2-pipe, multi-zone (2 zones) 3 HP AHU with three-way controlled HW/CHW coil, and face and bypass dampers. The AHU is served by one (1) ACR chiller outside on the South side of the bldg. The occupied portion of the basement is served by one (1) single zone DX AHU with condensing unit outside on the West side of bldg. Bldg. 131 is served by two (2), four-pipe multi-zone 7.5 HP AHU's with three-way controlled HW and CHW coils, and one ACR chiller on the East side of the building. See HVAC Equipment Lists for details.

HEATING EQUIP: Heating for Bldg. 126 is provided by individual radiators in the building served by HW boiler in the basement. See above for bldg. 129 air-side heating which is served by HW boiler in basement. Bldg. 131 is served by the above air-side system and one (1) high efficiency HW boiler (with one stand-by boiler), with hot water reset control, located in the basement. The entrance vestibule for bldg. 131 is served by a heating only FCU. See HVAC Equipment Lists for details.

LIGHTING: Surface mounted, 2-lamp fluorescent fixtures serve bldgs. 126 & 129 with 129 also lit by recessed, 4-lamp fluorescent fixtures. Bldg. 131 has 2'/4' 3-lamp fluorescent fixtures with electronic ballast.

DOMESTIC WATER HEATING: Bldgs. 126 & 129 have no domestic water heater. However,

bldg. 131 is served by a 100 gal gas fired DHW heater.

OTHER: Bldg. 126 - one (1) HW pump and one (1) CHW pump. Bldg. 129 - split system computer room unit serves computer room on first floor. Also, one HW/CHW pump and basement convertors. Bldg. 131 - two HW pumps (1 stand-by), one CHW pump, and exhaust fan for restrooms which operates continuously, and ventilation fan for mechanical room which is controlled by outside t-stat. See HVAC Equipment Lists for details.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Bldg. 129 boiler was designed to be controlled by an outside t-stat; however, it was currently not operating as such. Also, bldg. 129 has a 4-pipe to 2-pipe manual changeover arrangement, and a minimum outside air duct. Bldg. 131 had recently been renovated (but currently unoccupied) so that all the mechanical equipment was new and the controls operating properly.

## BUILDING DESCRIPTION

NAME: Buildings 125, 127, & 135

USE: Administrative offices - Community Operations Div., J. A. office, U.S.M.A. Admin. Field office. Continuous occupancy of approximately 5 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 1,593 STORIES: 1 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: Single pane clear glass

COOLING EQUIP: Building 125 is the only one of these buildings that has fan coils. Building 135 has a single zone 3 HP AHU, while building 127 has a residential type furnace unit with evaporator coil. Bldgs. 125 and 135 are both served by air cooled chillers that also serve adjacent building 124 and 134. Building 127 is served by a 4.5 ton outdoor condensing unit. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. Heating water for bldg. 125 and 135 is provided by a boiler in the basement of buildings 124 and 134. the furnace in Bldg. 127 is served by gas. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

OTHER: One (1) CHW pump and HW pump in bldg. 125.

DOMESTIC WATER HEATING: Electric hot water heater in building.

REMARKS: Poor temperature control, very hot inside during the field visit. All HVAC equipment appeared to be in fair to poor condition, however most controls were not functioning properly.

**BUILDING DESCRIPTION**

NAME: Building 128

USE: Boys & Girls Scouts Offices.

GROSS AREA (SQ.FT.): 14,224 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Frame

EXTERIOR WALLS: Brick , stone, and siding

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Air handling units, fan coil units, and several window units serve all conditioned areas of the building. Units served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Electric hot water heater in building.

OTHER: One (1) CHW pump and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: This building was unavailable to be entered during site visit. Chiller appeared to be in fair condition.

## BUILDING DESCRIPTION

NAME: Building 133

USE: Administrative offices - Medical/Pharmaceutical operations. Continuous occupancy of approximately 50 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 13,232 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and siding

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: One (1) 4-pipe, multi-zone 10 HP AHU (five zones) serves the first floor, and one (1) 4-pipe fan coil units serves the basement of the building. Units served air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above cooling equipment is served by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: 40 gallon, gas fired DHW heater.

OTHER: One (1) CHW pump, and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Temperature control in good condition. Comfortable inside during the field visit. All HVAC equipment appeared to be in fair condition.

## BUILDING DESCRIPTION

NAME: Building 134

USE: Legal offices. Continuous occupancy of approximately 40 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 10,434 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Two (2) 5 HP and, one (1) 1 HP multi-zone AHU's with three-way controlled CHW and HW coils serving all conditioned areas of the building. Units served air cooled reciprocating chiller which also serves bldg. 135. See HVAC Equipment Lists for details.

HEATING EQUIP: Above cooling equipment is served by HW boiler in basement. See HVAC Equipment Lists for details..

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: One (1) CHW and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control, very hot inside during the field visit especially on second floor near window covered vestibule. All HVAC equipment appeared to be in fair to poor condition, however most controls were not functioning properly.

## BUILDING DESCRIPTION

NAME: Building 140

USE: Equal Employment Opportunity Office. Continuous occupancy of six (6) people weekdays between 8:00 A.M. and 5:00 P.M.

GROSS AREA (SQ.FT.): 1,593 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: One (1) 1 HP, single zone AHU that has three (3) VAV terminal boxes, and a three way controlled CHW coil and two-way controlled HW coil. This AHU is served by Bldg. 122 ACR chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment served by boiler in bldg. 122. See HVAC Equipment Lists for details.

LIGHTING: 2'/2', u-tube fluorescent fixtures

DOMESTIC WATER HEATING: One (1) 30 gallon gas fired domestic water heater in mechanical room has been disconnected.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Outside air is not available for this unit, and there is poor temperature control. VAV boxes apparently no longer operate, and the CHW actuator has been manually stuck open.

## BUILDING DESCRIPTION

NAME: Building 141

USE: National Association of Federal Employees. Continuous occupancy of five (5) people weekdays between 7:00 A.M. and 5:00 P.M.

GROSS AREA (SQ.FT.): 1,008 STORIES: 2 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1913

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Plaster

WINDOWS: single pane clear glass

COOLING EQUIP: Two (2) window unit heat pumps provide both heating and cooling. One is located upstairs and the other is located downstairs. See HVAC Equipment Lists for details.

HEATING EQUIP: See above. See HVAC Equipment Lists for details.

LIGHTING: suspended fluorescent 2'/4', 2-lamp fixtures

DOMESTIC WATER HEATING: One (1) 30 gallon gas fired domestic water heater in mechanical room which does not operate.

REMARKS: These two units maintain good temperature control throughout year.

## BUILDING DESCRIPTION

NAME: Buildings 142

USE: Administrative offices - Reg. H.Q. and deferred maintenance.

GROSS AREA (SQ.FT.): 4,735 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and CMU

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: Single pane clear glass

COOLING EQUIP: This building is served by an air cooled chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: HW boiler in the basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Electric hot water heater in building.

REMARKS: This building was unavailable to be entered during site visit. Chiller appeared to be in fair condition. This building has it's own electrical meter.

## BUILDING DESCRIPTION

NAME: Buildings 143, 144, 145,146

USE: Administrative offices. Continuous occupancy of approximately 50 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 13,483 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry with frame add-on

EXTERIOR WALLS: Brick, stone and wood shingles

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass and tempered glass for enclosed porch

COOLING EQUIP: Bldgs. 143, 144, and 146 are served by 4-pipe, multi-zone and single-zone air handling units with three way controlled CHW and HW coils, and bldg 145 contains packaged window units for cooling. The air handlers in bldg 143, 144, & 146 are served by air cooled reciprocating chillers. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. The air handlers in bldgs. 143, 144, & 146 are served by HW boilers in the basements. Warm air furnace provides heating for bldg. 145. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heaters in buildings.

OTHER: One HW pump and CHW pump in each building. Building 144 also has a 4 ton condensing unit that serves computer room. See HVAC Equipment Lists for details.

REMARKS: Building 143 was empty and awaiting renovation at the time of the site visit. Window units are in poor condition and thus create maintenance problems. All other HVAC equipment appeared to be in fair to poor condition and most controls were not functioning properly.

## BUILDING DESCRIPTION

NAME: Buildings 147 & 149

USE: Billeting for Reserves, Family Residence. Continuous occupancy of approximately 50 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 11,522 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1939

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: One (1) 10 HP multi-zone air handling unit serves each of these buildings. ACR chiller serves both bldg. 147 & 149. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler in each bldgs. basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures and scattered incandescent fixtures.

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: One (1) CHW pump, and two (2) HW pumps. See HVAC Equipment Lists for details.

REMARKS: All HVAC equipment appeared to be in fair to poor condition. Piping between buildings appears to be deteriorating.

## BUILDING DESCRIPTION

NAME: Building 151, 154, 156, 157, 159

USE: Military Honor's Platoon, Ninety Fourth Medical Detachment, Fifth Army Band, M.P. Company Orderly Room and Command Office. Bldgs. 154 & 156 are continuously occupied between approximately 7:00 A.M. and 4:00 P.M. Bldg. 151 was currently unoccupied, and bldg. 157 is occupied only half a day for three days out of the week. Bldg. 159 is a twenty-four hour operation with four people during the daytime hours and one (1) person during the night.

GROSS AREA (SQ.FT.): 1,860 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945 & 1946

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles or clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet in all buildings except 157 which has vinyl coated tile

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Window unit heat pumps serve every bldg. except 159 which is served by a residential type fan and coil system with a split system heat pump outside. See HVAC Equipment Lists for details.

HEATING EQUIP: In bldgs. 151 & 154, the heat pumps utilize electric resistance heat. However, in bldg. 156; heating is provided by one (1) boiler that serves HW radiators in bldg. Bldg. 157 is served by gas fired unit heaters in the space, and a residential gas furnace serves bldg. 159. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' recessed 2-lamp and 4-lamp fluorescent fixtures in all the bldgs.

DOMESTIC WATER HEATING: Bldg. 154 does have 10 gallon DHW electric heater which is not operating, and bldg. 156 has abandoned steam boiler and heat exchanger. The rest of the buildings do not have DHW generating capabilities.

OTHER: One (1) restroom fan serves bldg. 154, and bldg. 156 has a HW pump. Two (2) dehumidifiers condition the air for the vault in bldg. 159.

REMARKS: Domestic water for the building is not available due to a base wide policy. Bldg. 151 was abandoned at the time of the site visit. Bldg. 154 has steam radiators that are no longer used. Bldg. 156 has an abandoned steam boiler and domestic hot water storage tank, the HW pump for his same bldg. operates continuously. Bldg. 157 is occupied on an as needed basis.

## BUILDING DESCRIPTION

NAME: Building 152

USE: Civilian Training Office - administration and classroom space. Continuously occupied by 8 people between approximately 7:00 A.M. and 4:00 P.M. Classes are occupied an average of once per week with 40 people per classroom (2 classrooms).

GROSS AREA (SQ.FT.): 8,457 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945 & 1946

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Eight (8) cooling only window units serve the bldg. See HVAC Equipment Lists for details.

HEATING EQUIP: Ten (10) gas fired space heaters located on the floor heat the space. See HVAC Equipment Lists for details.

LIGHTING: 8' suspended fluorescent fixtures and 2'/4' recessed fluorescent fixtures

DOMESTIC WATER HEATING: N/A

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water.

# BUILDING DESCRIPTION

NAME: Building 155

USE: Research Management Division, Plans and Ops., Directorate Planning, Security and Mobilization, Training, Emergency Operation Center (EOC), Visual Eq. of Base. Continuously occupied by 15 people between approximately 7:00 A.M. and 4:00 P.M.

GROSS AREA (SQ.FT.): 7,374 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Vinyl coated tile and carpet

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: The secured EOC area in the basement is served by a 1/4 HP four-pipe, three-way controlled CHW and HW vertical FCU. The other occupied area of the basement is served by a ½ HP four-pipe, three-way controlled CHW and HW single zone AHU. These units are served by two (2) split system condensing units located outside on the East side of the building that are piped to a heat exchanger in the basement mechanical room that exchanged heat between the chilled water and the refrigerant. The rest of the building is served by eight (8) packaged window units. See HVAC Equipment Lists for details.

HEATING EQUIP: See above for air-side equipment. The basement units are served by HW boiler located in the basement mechanical room, and the window units all have electric resistance heat. The restrooms have space heaters that do not operate. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' 2-lamp pendant mounted fluorescent fixtures on the first floor and 2'/4' 4-lamp surface mounted fluorescent fixtures in the basement.

DOMESTIC WATER HEATING: None

OTHER: Small restroom exhaust fan which is interlocked with the lights

REMARKS: Domestic water for the building is not available due to a policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water.

## BUILDING DESCRIPTION

NAME: Building 158

USE: Company A Support and Training which includes supply, conference, training and office areas. Continuous occupancy by 12 people between 6:00 A.M. and 6:00 P.M.

GROSS AREA (SQ.FT.): 6,429 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Vinyl coated tile

CEILINGS: Acoustical tile

WINDOWS: single pane clear glass

COOLING EQUIP: Eight (8) packaged window units. See HVAC Equipment Lists for details.

HEATING EQUIP: In the Supply area, the window units have electric resistance heat. In all other areas, eight (8) gas fired unit heaters provide the heat. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' recessed, 4-lamp fluorescent fixtures in the supply and office areas, and suspended, 2'/4' 2-lamp fluorescent fixtures in the conference room.

DOMESTIC WATER HEATING: Gas fired DHW heater in basement serves restrooms but is not operating.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Window units run continuously to maintain building setpoints. Room furnaces throughout building are no longer used.

# BUILDING DESCRIPTION

NAME: Buildings 197

USE: Headquarter of Fifth Army Band, future 323rd Medical Battalion Supply. Continuous occupancy of approximately 35 people during weekdays, between approximately 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 13,819 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Frame

EXTERIOR WALLS: Stucco

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile, Plaster

WINDOWS: Single pane clear glass

COOLING EQUIP: Three 3 HP, 4- Pipe, single-zone fan and coil units serve all conditioned areas of the building, and the space thermostats modulate the CHW and HW control valves. Units do have economizer control capabilities but it has been de-activated. Units served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in and surface mounted fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: One (1) CHW pump and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control, very hot inside during the field visit. Very old ductwork with dust mold and mildew. Control problems create moisture pockets on furniture and causes moisture problems with computers. All HVAC equipment appeared to be in poor condition, and most controls were not functioning properly.

## BUILDING DESCRIPTION

NAME: Building 198

USE: Physical/Medical Evaluation Board. Continuous occupancy of approximately 20 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 5,468 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1945

STRUCTURE: Frame

EXTERIOR WALLS: Stucco

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile, Plaster

WINDOWS: single pane clear glass

COOLING EQUIP: Two (2) single-zone fan and coil units serving all conditioned areas of the building. HW valves and CHW valves are modulated to maintain return air temperature. Units served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Surface mounted incandescent fixtures and fluorescent fixtures

DOMESTIC WATER HEATING: Electric water heater in building.

OTHER: One (1) CHW pump and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control. Air-side equipment is maintenance intensive. All HVAC equipment appeared to be in poor condition.

## BUILDING DESCRIPTION

NAME: Building 199

USE: Band Rehearsal Hall. Intermittent occupancy of approximately 60 people during weekdays, between 7:00 am and 5:00 pm.

GROSS AREA (SQ.FT.): 6,415 STORIES: 1 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION 1940

EXTERIOR WALLS: Stucco

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and carpet

CEILINGS: Plaster

WINDOWS: single pane clear glass

COOLING EQUIP: One multi-zone air handling unit serves all conditioned areas of the building. Unit is served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Recessed and surface mounted fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: One (1) CHW pump and one (1) HW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control. Area is critical to humidity control because instruments are susceptible to humidity. All HVAC equipment appeared to be in fair condition, however most controls were not functioning properly.

## BUILDING DESCRIPTION

NAME: Building 250

USE: NCO Academy, barracks, and future chef training school. Continuous occupancy of approximately 250 people between 5:00 pm and 7:00 a.m.

GROSS AREA (SQ.FT.): 42,955 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Stucco

ROOF: Flat built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete, tile and carpet

CEILINGS: Acoustical tile, gypsum wallboard, plaster

WINDOWS: single pane clear glass

COOLING EQUIP: Six (6), 7.5 HP, multi-zone air handling units with three-way controlled CHW coil , and two-way controlled steam coil serve the barracks portion of building and one multi-zone air handling unit with the same controls serves the future chef school. Hot and cold deck temperature setpoints are maintained by modulating CHW and steam valves, and space thermostats control zone dampers. Units do have economizer capabilities but they have been de-activated. All units are served by air cooled reciprocating chiller. See HVAC Equipment Lists for details.

HEATING EQUIP: See cooling equipment above. All heating coils in the air handlers are steam. Steam is provided by steam boiler in basement. See HVAC Equipment Lists for details.

LIGHTING: Lay-in fluorescent fixtures in future chef school, admin, and barracks; surface mounted incandescent and fluorescent fixtures in barracks.

DOMESTIC WATER HEATING: Gas fired hot water heater in building.

OTHER: CHW pump. See HVAC Equipment Lists for details.

REMARKS: Poor temperature control, very hot inside during the field visit. The air cooled chiller appeared to be in good condition and all other HVAC equipment appeared to be in fair condition.

## BUILDING DESCRIPTION

NAME: Building 260 & 261

USE: Bldg. 260 is currently unoccupied but Dispute Resolution Department will move into the building. Bldg. 261 is the Post Inspector General's Office with a continuous occupancy of 6 people between 7:30 A.M. and 4:30 P.M.

GROSS AREA (SQ.FT.): 1,756 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1940

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Wood and carpet

CEILINGS: Plaster in bldg. 260 and acoustical tile in bldg. 261

WINDOWS: Single pane, clear glass

COOLING EQUIP: Five (5), 1/6 HP, three speed, two-pipe FCU's with wild coils located along the walls of each building are served by one (1) ACR chiller located between the buildings. One (1) wall mounted thermostat in each building appears to cycle on a compressor in the chiller according to the CHW supply temperature. See HVAC Equipment Lists for details.

HEATING EQUIP: HW boiler serves the above air-side equipment in both buildings and is located in the mechanical room of bldg. 260. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' 4-lamp, surface mounted fluorescent fixtures and 2'/4' suspended 2-lamp fluorescent fixtures in bldg. 260. 2'/4' recessed fluorescent fixtures in office space, and incandescent in copy room of bldg. 261.

DOMESTIC WATER HEATING: Gas fired 30 gallon DHW heater in mechanical room serves restrooms in bldg. 260 but is not operating, and none in bldg. 261.

OTHER: One (1) CHW/HW pump for two-pipe application in each building mechanical room.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Manual changeover valves for boilers were not closed during the site visit which results in the chilled water flow running through the boiler and creates a greater head on the pump. Bldg. 261 has recently been renovated.

## BUILDING DESCRIPTION

NAME: Building 268

USE: FSH Resident Agency Sixth Region U.S. Army Criminal Investigation Command. Continuous occupancy of 25 people between 7:30 A.M. and 4:30 P.M.

GROSS AREA (SQ.FT.): 8,800 STORIES: 1 DATE OF SURVEY: 10/17/95 - 10/18/95

DATE OF CONSTRUCTION: 1982

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof with slates

FLOOR CONSTRUCTION: Slab on grade

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: Single pane, clear glass

COOLING EQUIP: Three (3), 1/3 HP, 4-pipe, three-way controlled FCU's are located in the building above the ceiling. A fourth, 7.5 HP, 4-pipe, three-way controlled AHU ("Texas Multi-zone Unit") is located in the main mechanical room and has six zones with duct mounted heating coils in each zone. All units are served by ACR chiller outside on the East side of the building. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW boiler and is located in the main mechanical room of this building. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' 2-lamp, recessed fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired 100 gallon DHW heater and tank and is operating.

OTHER: One (1) base mounted CHW pump, one (1) in-line HW pump, and one (1) DHW pump. One (1) exhaust fan serves restroom, one (1) floor mounted dehumidifier in space, and small ventilation fan for mechanical room.

REMARKS: Three-way control valve for boilers has been dismantled. Also, some three-way control valved for the water systems are inoperative because the actuators have been installed upside down which floods the element in the actuator. The chilled water system for this building operates year round.

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Hot Water Boiler | 1 | Rite #HD-85<br>natural draft, watertube<br>618 MBH output | Bldg. 122 & 140 | 1985 | 850 MBH |
| Heating Water Pump | 2 | B&G model 1.5 x 7B 83/4 BF<br>32 gpm, 50 ft<br>1.5 HP | Bldg. 122 & 140 | 1985 | 1.12 KW |
| Water Chiller | 1 | Trane #CGABC401AF01FK, 40 tons<br>Comp-1, 460 V, 3 ph, 31.3 RLA<br>Fan-4, 460 V, 3 ph, 31.3 RLA | Bldg. 122 & 140 | 1985 | 70 KW |
| Chilled Water Pump | 2 | N/A<br>3 HP | Bldg. 122 & 140 | 1985 | 2.24 KW |
| Cooling Tower | 1 | Halstead & Mitchell<br>cross flow # CP-40<br>2 HP Fan, 35 tons cooling | Bldg. 123 | 1985 | 1.49 KW |
| Cond. Pump | 1 | No name plate<br>3 HP | Bldg. 123 | 1985 | 2.24 KW |
| Water Cooled Pack. FCU | 4 | Fedders, # GAWO65088<br>Comp 1, 208 V, 14.5 FLA,<br>Blower 1/2 HP | Bldg. 123 | 1980 | 23.29 KW |
| Water Cooled Pack. FCU | 1 | Chrysler # 106-00R<br>Comp 1, 208 V, 23 FLA,<br>Blower 1/2 HP | Bldg. 123 | 1980 | 9.24 KW |
| Water Cooled Pack. FCU | 1 | Weather King # SW 90 3A<br>Comp 2, 208 V, 18.2 FLA,<br>Fan 0.75HP | Bldg. 123 | 1980 | 7.31 KW |
| Space Heaters | 5 | Gas, over head<br>Name and capacity unknown<br>140 MBH design heating | Bldg. 123 | 1980 | 195.4 MBH |
| Dehumidifier | 14 | Model # D-1600<br>1/6 HP, 115 V, total 3.4 A per unit<br>refrigerant - 500 | Bldg. 123 | 1985 | 6.04 KW |
| Hot Water Boiler | 1 | Ajax, inclined<br>natural draft, watertube, 200 F<br>618 MBH output | Bldgs. 124, 125 | 1985 | 850 MBH |
| Heating Water Pumps | 2 | Amtrol<br>23 GPM, 50 ft<br>1.5 HP | Bldgs. 124, 125 | 1985 | 1.12 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | TSI #30-AOCD65, 50 tons<br>Comp-1, 460 V, 56 RLA, Comp-1, 48 RLA<br>Fan-4, 460 V, 31.3 RLA | Bldgs. 124, 125 | 1985 | 88 KW |
| Chilled Water Pumps | 2 | Mueller<br>53 gpm, 71 ft<br>3 HP | Bldgs. 124, 125 | 1985 | 2.24 KW |
| Air Cooled Chiller | 1 | Trane, # CGABC403AE00F<br>2 Comp. 62.8 RLA, 230 V.<br>4 Cond. fans 1 HP ea., 40 tons | Bldg. 126 | 1985 | 58.45 KW |
| Chilled Water Pump | 1 | Armstrong<br>2 HP | Bldg. 126 | 1985 | 1.49 KW |
| HW Water Pump | 1 | 1 HP<br>No name plate | Bldg. 126 | 1985 | 0.746 KW |
| HW Boiler | 1 | National<br>587 MBH output | Bldg. 126 | 1985 | 810 MBH |
| Split System Furnace | 1 | RUUD<br>33 MBH output | Bldg 127 | 1985 | 45 MBH |
| Condensing Unit | 1 | RUUD #UACC-056JAS<br>4.5 ton, 7 EER | Bldg 127 | 1985 | 7.71 KW |
| Hot Water Boiler | 1 | N/A<br>109 MBH output | Bldg. 128 | 1985 | 150 MBH |
| Heating Water Pump | 1 | N/A<br>1/2 HP | Bldg. 128 | 1985 | 0.37 KW |
| Air Cooled Chiller | 1 | Trane #CGABC403AE00F, 40 tons<br>Comp-2, 230 V, 62.8 RLA<br>Fan-4, 230 V, 3.6 RLA | Bldg. 128 | 1985 | 58.50 KW |
| Chilled Water Pump | 1 | N/A<br>1.5 HP | Bldg. 128 | 1985 | 1.12 KW |
| Air Cooled Chiller | 1 | York, # YCAZ33JD346, 54.4 GPM<br>2 Comp. 25.3 RLA, 460 V<br>2 Cond. fans 1.5 HP ea., 25 tons | Bldg.129 | 1988 | 46 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Air Cooled Cond. | 2 | Larkin, # FCA 26<br>3 fans/ unit, 2.0 FLA/ fan, 10 tons<br>for comp. rm. units and not modeled | Bldg.129 | 1990 | 2.29 KW |
| Air Cooled Cond. | 1 | Rudd # UACC048JAS<br>208 V, 28.2 AMP<br>3 tons | Bldg.129 | 1992 | 6.1 KW |
| HW / CHW Water Pump | 1 | Armstrong<br>3 HP, 2 pipe system | Bldg.129 | 1988 | 2.38 KW |
| HW Boiler | 1 | AJAX # G 24783<br>108.8 MBH output | Bldg.129 | 1971 | 154.7 MBH |
| HW Circulator | 1 | TACO # 8-91<br>3/4 HP | Bldg.129 | 1991 | 0.56 KW |
| Air Cooled Chiller | 1 | McQuay # ALR030C, 29 tons<br>Comp. 1ea. 35 HP, 56 RLA<br>Fan 2 ea. 2 FLA & 1 ea. 5.6 FLA | Bldg.131 | 1994 | 37.8 KW |
| Chilled Water Pmp | 1 | Taco<br>92.5 GPM, 55 ft head, 3 HP | Bldg.131 | 1994 | 2.24 KW |
| HW boiler | 1 | Teledyne # HH0250CN12KBAX<br>201.0 MBH output<br>non-modulating | Bldg.131 | 1995 | 250 MBH |
| HW Pumps | 2 | Taco inline (1-standby)<br># 1651C3N2 5.75<br>3/4 HP | Bldg.131 | 1995 | 0.56 KW |
| Hot Water Boiler | 1 | Ajax #WGHD-150<br>forced draft, 5 HP blower<br>109 MBH output | Bldg. 133 | 1985 | 150 MBH<br>3.73 KW |
| Heating Water Pump | 1 | N/A<br>1/2 HP | Bldg. 133 | 1985 | 0.37 KW |
| Water Chiller | 1 | Trane #CGABC256AF01FK, 25 tons<br>Comp. 1ea. 200 V, 3 ph, 56 RLA<br>Fan 3 ea. 200 V, 3 ph, 4.1 FLA tot | Bldg. 133 | 1985 | 44 KW |
| Chilled Water Pump | 1 | Aurora<br>40 gpm, 70 ft<br>1.5 HP | Bldg. 133 | 1985 | 1.12 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Hot Water Boiler | 1 | Thermopak #GWE 825<br>watertube<br>596 MBH output | Bldgs 134, 135 | 1985 | 820 MBH |
| Heating Water Pump | 1 | Armstrong, close coupled<br>1/2 HP | Bldgs 134, 135 | 1985 | 0.37 KW |
| Water Chiller | 1 | Trane #CGACC306KANDD303EG, 30 ton<br>Comp. 1ea. 200 V, 3 ph, 103.2 RLA<br>Fan 3 ea. 200 V, 3 ph, 2.1 FLA tot | Bldgs 134, 135 | 1985 | 53 KW |
| Chilled Water Pump | 1 | Armstrong, close coupled<br>63 ft,<br>1/2 HP | Bldgs 134, 135 | 1985 | 0.37 KW |
| Window Units | 2 | Friedrich # EL19H35B<br>19,000 BTUH clg. & 17,300 BTUH htg.<br>10 EER | Bldg.141 | 1993 | 3.7 KW |
| Hot Water Boiler | 1 | N/A<br>327 MBH output | Bldg. 142 | 1985 | 450 MBH |
| Heating Water Pump | 1 | N/A<br>1/2 HP | Bldg. 142 | 1985 | 0.37 KW |
| Water Chiller | 1 | Carrier #30GT-020-500<br>air cooler, recip.<br>10 tons | Bldg. 142 | 1985 | 18 KW |
| Chilled Water Pump | 1 | N/A<br>1 HP | Bldg. 142 | 1985 | 0.75 KW |
| Water Chiller | 1 | N/A<br>air cooled, recip.<br>45 tons | Bldg. 143 | 1985 | 70 KW |
| Chilled Water Pump | 1 | N/A<br>3 HP | Bldg. 143 | 1985 | 2.24 KW |
| Hot Water Boiler | 1 | N/A<br>596 MBH output | Bldg. 143 | 1985 | 820 MBH |
| Heating Water Pump | 1 | N/A<br>1/2 HP | Bldg. 143 | 1985 | 0.37 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | TSI #CA2CD 45<br>Comp-2, 230 V, 3 ph, 1 ea 71.4 A, 1 ea 88.5 A<br>45 tons | Bldg. 144 | 1985 | 70 KW |
| Chilled Water Pump | 1 | Aurora<br>58 gpm, 86 ft<br>3 HP | Bldg. 144 | 1985 | 2.24 KW |
| Hot Water Boiler | 1 | Bryan<br>596 MBH output | Bldg. 144 | 1985 | 820 MBH |
| Heating Water Pump | 1 | B&G<br>1 HP | Bldg. 144 | 1985 | 0.75 KW |
| Terminal Cooling Unit | 1 | Data Temp #DTA-0532-01<br>Russell #TD6.5 condenser<br>4 ton, 9 EER | Bldg. 144 | 1985 | 5.81 KW |
| Window A/C Units | 23 | Fredrich #MDD YL 24H3513<br>2 ton clg, 22.4 MBH htg.<br>9 EER | Bldg. 145 | 1985 | 61.33 KW |
| Hot Water Boiler | 1 | Teledyne Laars<br>596 MBH | Bldg. 146 | 1985 | 820 MBH |
| Heating Water Pump | 1 | N/A<br>1 HP | Bldg. 146 | 1985 | 0.75 KW |
| Water Chiller | 1 | Trane #CGABC404AF00F1K, 40 tons<br>Comp-2, 460 V, 3 ph, 31.3 RLA ea<br>Fan-4, 460 V, 3 ph, 1 HP ea. | Bldg. 146 | 1985 | 58 KW |
| Chilled Water Pump | 1 | Taco<br>83 gpm,<br>1.5 HP | Bldg. 146 | 1985 | 1.12 KW |
| Hot Water Boiler | 1 | Ajax #WG-750-5<br>155 F HWS<br>596 MBH output | Bldg. 147 | 1985 | 820 MBH |
| Heating Water Pump | 1 | Taco<br>1 HP | Bldg. 147 | 1985 | 0.75 KW |
| Water Chiller | 1 | McQuay #ALR 040AD, 50 tons<br>Comp-2, 208 V, 3 ph, 64 A & 76 A<br>Fan-4, 208 V, 3 ph, 10.6 A tot | Bldgs 147, 149 | 1985 | 59.80 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Chilled Water Pump | 1 | Paco<br>5 HP | Bldgs 147, 149 | 1985 | 3.73 KW |
| Hot Water Boiler | 1 | Thermopak #GWE 825<br>220 F HWS<br>596 MBH output | Bldg. 149 | 1985 | 820 MBH |
| Heating Water Pump | 1 | Paco<br>40 gpm, 40 ft<br>1 HP | Bldg. 149 | 1985 | 0.75 KW |
| Window Units | 2 | 1.5 tons ea.(clg. and htg.)<br>19,000 BTUH clg. & 17,300 BTUH htg.<br>9 EER | Bldg.151 | 1985 | 4.4 KW |
| Window Units | 8 | Friedrich<br>19,000 BTUH clg. & 17,300 BTUH htg.<br>10 EER | Bldg.152 | 1993 | 14.91 KW |
| Gas Fired Rm. Heaters | 10 | Dearborn<br>No name plate<br>115 MBH design heating load | Bldg.152 | 1985 | 157.3 MBH |
| Window Units | 4 | Friedrich<br>19,000 BTUH clg. & 17,300 BTUH htg.<br>9 EER | Bldg.154 | 1985 | 8.89 KW |
| Air Cooled Cond. | 2 | Trane # TTB748A100A0<br>208 V, 24 RLA<br>5 ton | Bldg.155 | 1988 | 10.8 KW |
| HW boiler | 1 | Hydrotherm<br>47.17 MBH output | Bldg.155 | 1985 | 65 MBH |
| HW Pump | 1 | Taco inline<br># 1612C2N10 5.75<br>3/4 HP | Bldg.155 | 1985 | 0.56 KW |
| CHW Pump | 1 | Taco inline<br># 1612C2N20 6.35<br>3/4 HP | Bldg.155 | 1988 | 0.56 KW |
| Window Units | 8 | 19,000 BTUH clg. & 17,300 BTUH htg.<br>9 EER | Bldg.155 | 1985 | 17.79 KW |
| Window Units | 7 | 19,000 BTUH clg.<br>9 EER | Bldg.156 | 1985 | 16.29 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| HW boiler | 1 | Richmond, Type 26SC<br>125.1 MBH output | Bldg.156 | 1980 | 174.4 MBH |
| HW Pump | 1 | Bell & Gosset inline circulator<br>1/4 HP | Bldg.156 | 1985 | 0.19 KW |
| Window Units | 2 | Friedrich - 1.5 tons<br>Fedder - 1.0 ton<br>9 EER | Bldg.157 | 1985 | 3.68 KW |
| Gas Space Heaters | 2 | No name plate<br>16.74 MBH design heating | Bldg.157 | 1980 | 35 MBH |
| Window Units | 8 | Friedrich, 1.0 ton ea. No heat<br>Signature model 2000, 9 EER | Bldg.158 | 1985 | 11.76 KW |
| Gas Floor Furnaces | 8 | 26 MBH in each<br>18.65 MBH out each | Bldg.158 | 1980 | 208 MBH |
| Gas Furnaces | 1 | No name plate<br>16.74 MBH design heating | Bldg.159 | 1980 | 35 MBH |
| Split System | 1 | Bryant # 593CP036-B<br>208 V, 10 RLA<br>3 ton | Bldg.159 | 1990 | 3.81 KW |
| Hot Water Boiler | 1 | Ajax #WG-1750<br>1400 MBH output | Bldg. 197 | 1985 | 1,750 MBH |
| Heating Water Pump | 1 | B&G<br>1 HP | Bldg. 197 | 1985 | 0.75 KW |
| Water Chiller | 1 | York #LCHA 50-17A, 50 tons<br>Comp-2, 200 V, 3 ph, 81 & 117 RLA<br>Fan-7, 200 V, 3 ph, 8.4 RLA tot | Bldg. 197 | 1985 | 78.8 KW |
| Chilled Water Pump | 1 | Peerless<br>2 HP | Bldg. 197 | 1985 | 1.49 KW |
| Hot Water Boiler | 1 | National #209-7<br>natural draft<br>327 MBH output | Bldg. 198 | 1985 | 450 MBH |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100

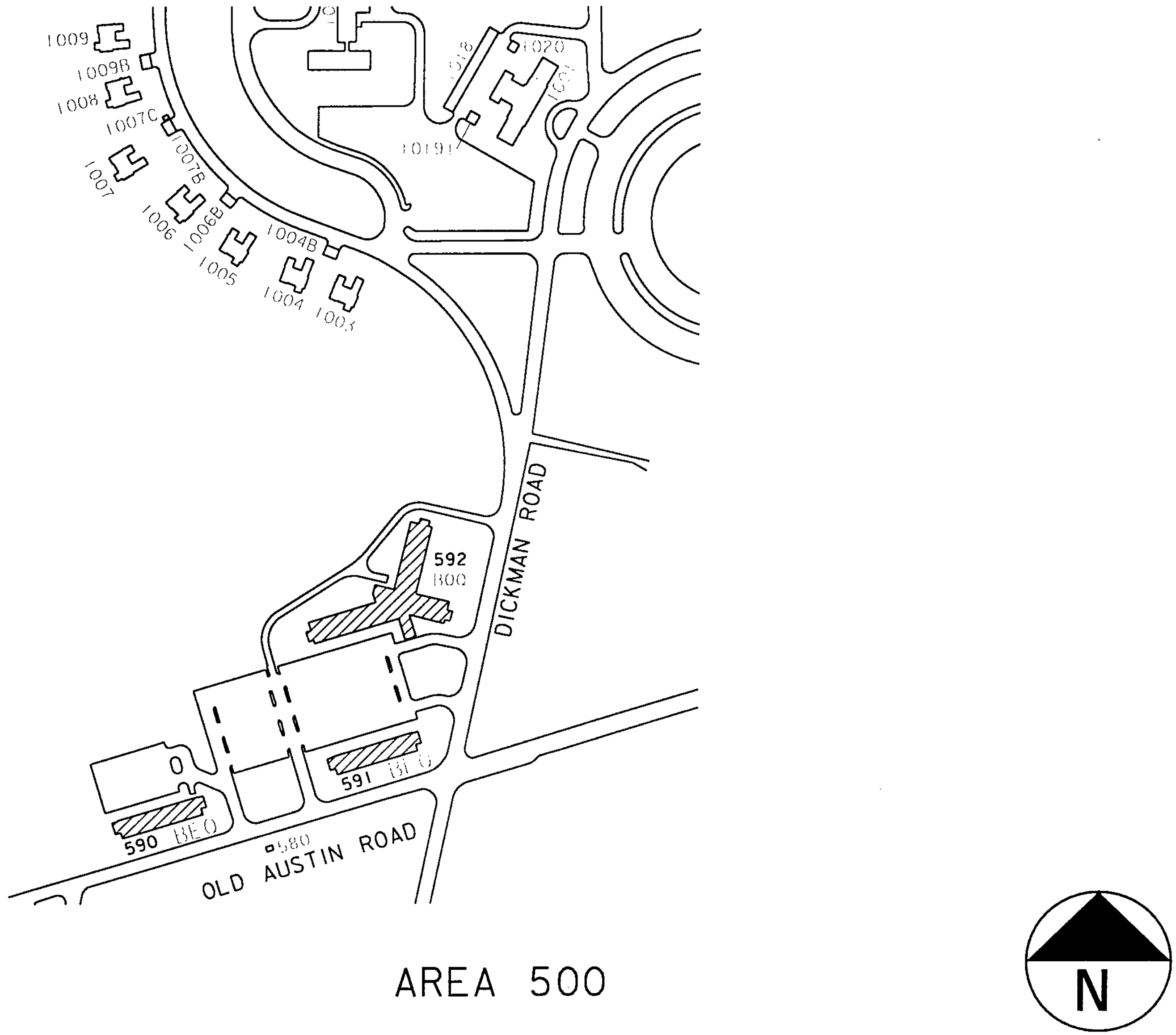
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Heating Water Pump | 1 | Taco<br>3/4 HP | Bldg. 198 | 1985 | 0.56 KW |
| Water Chiller | 1 | Trane #MAUG-C156-B, 10 tons<br>Comp-2, 230 V, 3 ph, 27.1 RLA ea<br>Fan-3, 230 V, 3 ph, 5.0 RLA tot | Bldg. 198 | 1985 | 14 KW |
| Chilled Water Pump | 1 | N/A<br>1.5 HP | Bldg. 198 | 1985 | 1.12 KW |
| Hot Water Boiler | 1 | Ajax #WG-200-S<br>natural draft<br>145 MBH output | Bldg. 199 | 1985 | 200 MBH |
| Heating Water Pump | 1 | N/A<br>1.5 HP | Bldg. 199 | 1985 | 1.12 KW |
| Water Chiller | 1 | RUUD #RAWC 150 CAS, 15 tons<br>Comp-1, 208 V, 3 ph, 59.6 RLA<br>Fan-2, 208 V, 3 ph, 4.4 RLA tot | Bldg. 199 | 1985 | 26 KW |
| Chilled Water Pump | 1 | N/A<br>2 HP | Bldg. 199 | 1985 | 1.49 KW |
| Steam Boiler | 2 | Kewanee #581, series 3X<br>726 MBH output each | Bldg. 250 | 1985 | 1,000 MBH |
| Water Chiller | 1 | Trane #CGACD111, 100 tons<br>Comp-2, 460 V, 3 ph, 98.0 & 78.0 RLA<br>Fan-12, 460 V, 3 ph, 1.8 RLA ea | Bldg. 250 | 1985 | 173.6 KW |
| Chilled Water Pump | 1 | Paco<br>7.5 HP | Bldg. 250 | 1985 | 5.60 KW |
| Air Cooled Chiller | 1 | Trane, # CGAA0153HF53CC5C4A311CK<br>2 Comp. 208 V, 33 RLA ea.<br>Cond. Fan 3 ea. 0.33 HP ea., 15 tons | Bldg.260 & 261 | 1985 | 27 KW |
| CHW / HW Pump | 1 | Pace pump # BACH 100<br>1/2 HP, | Bldg.260 & 261 | 1985 | 0.37 KW |
| HW Boiler | 1 | Name plate painted over<br>47.4 MBH design heating | Bldg.260 & 261 | 1980 | 66 MBH |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 100

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Chilled Water Pump | 1 | B & G, size 3525, 1/2 HP | Bldg.261 | 1985 | 0.37 KW |
| Air Cooled Chiller | 1 | Trane # CGACC203KBNB200<br>Comp. 1 ea. 62.8 RLA, 230 V.<br>Cond. fan 2 ea. 1 HP. ea., 20 tons | Bldg.268 | 1993 | 27.3 KW |
| HW boiler | 1 | Peerless Boilers # G - 661<br>125.1 MBH out | Bldg.268 | 1993 | 160 MBH |
| HW pump | 1 | Taco # 163GN2 5.65<br>3/4 HP | Bldg.268 | 1993 | 0.56 KW |
| CHW pump | 1 | Taco # FM 1207 5.75 B2A1A1I2<br>40 GPM, 30 ft head<br>3/4 HP | Bldg.268 | 1993 | 0.56 KW |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DICKMAN ROAD
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BEQ
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BEQ
580
OLD AUSTIN ROAD
N

AREA 500

## BUILDING DESCRIPTION

NAME: Building 590 & 591

USE: Advanced Non-Commissioned Officers Quarters - barracks. One (1) person per room with 57 rooms per building. Approximately 80% current occupancy.

GROSS AREA (SQ.FT.): 21,940 STORIES: 3 DATE OF SURVEY: 10/19/95

DATE OF CONSTRUCTION: 1956

STRUCTURE: Masonry

EXTERIOR WALLS: Stucco on CMU

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: Single pane, double hung, clear glass

COOLING EQUIP: Three (3), 5 HP, four pipe, multi-zone ( three zones) AHU with wild CHW and HW coils and face and bypass control. AHU's in each bldg. are served by ACR chiller located on the East side of each bldg. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by HW, water tube boiler that has no modulation in basement of each building. Boiler has three-way control on primary side and hot water reset capabilities. See HVAC Equipment Lists for details.

LIGHTING: Surface mounted, 4-lamp fixtures in rooms (along with incandescent bulbs), and surface mounted 1-lamp fixtures in corridors.

DOMESTIC WATER HEATING: One (1) water tube steam boiler with duplex condensate return unit serves a steam-to-DHW heat exchanger & tank (generator) in basement of each building which is then pumped to building.

OTHER: One (1) base mounted CHW pump & HW pump in each bldg. basement, and one (1) in-line DHW pump. Mechanical room propeller vent fan.

REMARKS: Min/max OA damper actuator for all three AHU's on exterior mechanical room wall have been disconnected. Return air is through corridor, and the mechanical room is used as a plenum space. First floor AHU's are larger to handle the lounge area and the extra wings.

## BUILDING DESCRIPTION

NAME: Building 592

USE: Unaccompanied Personnel Housing - barracks. Two (2) person per room with 192 rooms per building. Approximately 80% current occupancy.

GROSS AREA (SQ.FT.): 127,537 STORIES: 5 DATE OF SURVEY: 10/19/95

DATE OF CONSTRUCTION: 1975

STRUCTURE: Masonry

EXTERIOR WALLS: Brick, stucco, and precast concrete panels

ROOF: Flat, built-up roof with pitched clay tile on penthouse

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Plaster in quarters, and 2'/2' & 2'/4' acoustical tile in corridors and office areas

WINDOWS: Single pane, operable, double hung, clear glass

COOLING EQUIP: Five, 15 HP, 4-pipe, multi-zone AHU's with wild CHW coils, three-way controlled HW coils, and face and bypass control. First floor AHU's have five zones while all other floors have six zones. Coil control valves are controlled by leaving coil temperature setpoints, and the space temperature controls the zone dampers. Economizer cycle has been de-activated. All of these AHU's is served by a R-123 centrifugal chiller which has no bypass control located in the central plant adjacent to the first floor mechanical room. The three-way controlled cooling tower is located outside the central plant. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by watertube, HW boiler in central plant. Boiler has hot water reset schedule that has been de-activated. See HVAC Equipment Lists for details.

LIGHTING: Recessed, 4-lamp fixtures in rooms (along with incandescent bulbs) and corridors. Surface mounted fluorescents in the laundries.

DOMESTIC WATER HEATING: One (1) 1250 MBH, water tube DHW boiler provides DHW to a 1340 gallon storage tank.

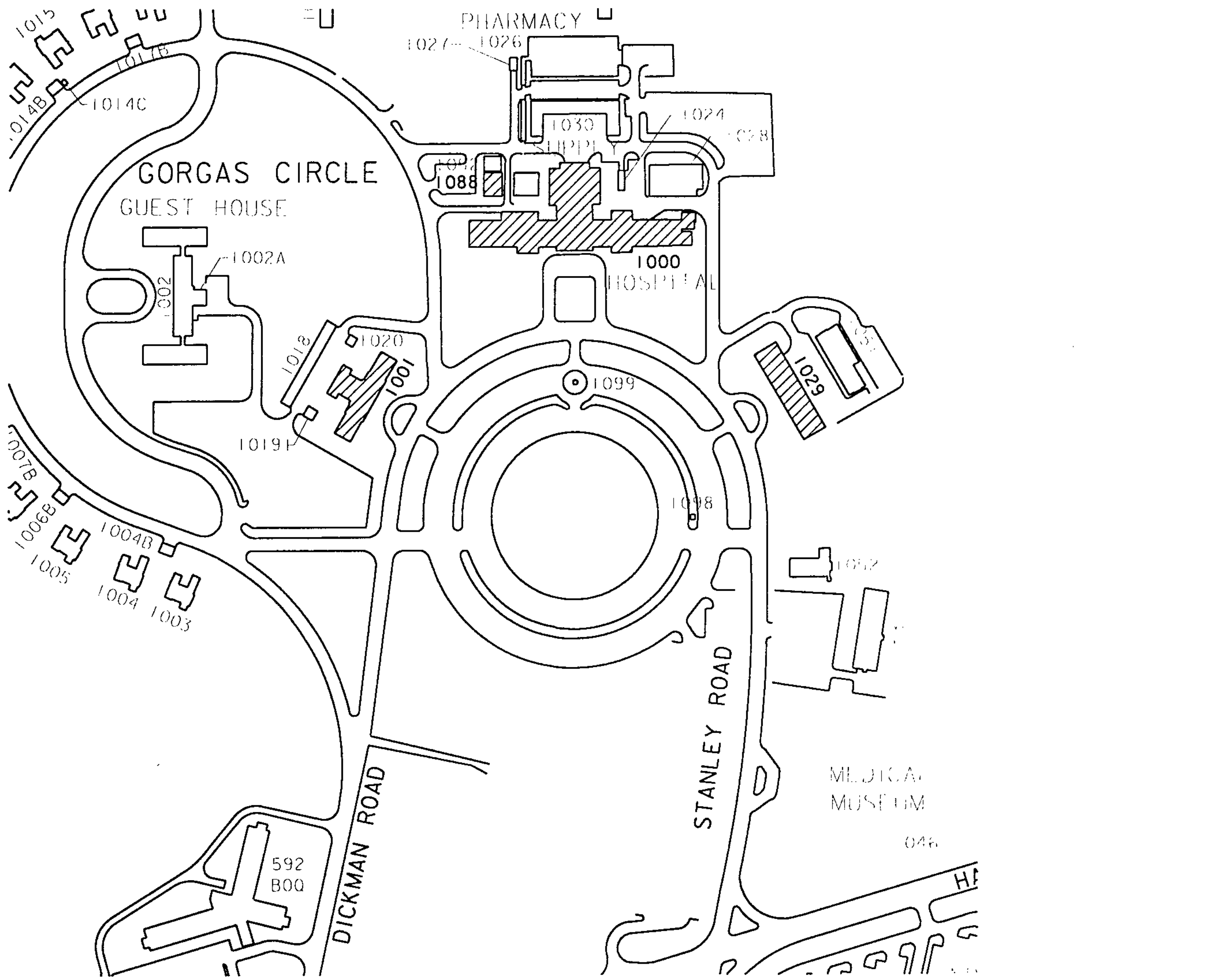
OTHER: One (1) central exhaust fan in central plant for building exhaust. One (1) base mounted CHW pump & HW pump in each bldg. basement, and one (1) in-line DHW pump, and DCW primer pump.

REMARKS: Min/max OA damper actuators for all AHU's on exterior mechanical room wall have been disconnected. Return air is through plenum space above corridor ceiling, and the mechanical room is used as a plenum space. Roll filters are used in all AHU's. Chiller, at the time

of the site visit, is six months old. The temperature of the DHW storage tank is maintained at 138°F. Controllers have recently been upgraded from pneumatics to electronics. Building has had a recent lighting renovation where electronic ballasts with T-8 lamps and occupancy sensors have been installed. However, lighting levels appear to be extremely high in many areas. Ventilation fan in elevator room is not operational. Central exhaust was not working at time of site visit. Dryer vent exhaust duct is in mechanical room plenum space, and in a couple of instances; the vent covers were of and adding both heat and lint into the plenum space. Mixing valve for boiler was removed when boiler was replaced.

PROPOSED HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 500
JANUARY 29, 1995

| ITEM | QTY | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD | OPER. TIMES | | | ANNUAL USE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Air Cooled Chiller | 1 | Dunham Bush, # ACDRO70A, 460 V<br>2 Comp. 63.5 RLA,<br>6 Cond. fans 1.5 HP ea., 66.5 tons | Bldg. 590 | 1986 | 91.86 KW | 24 | 7 | 26 | | |
| Chilled Water Pump | 1 | Aurora # D 6466, 5 HP<br>135 GPM, 42 ft head<br>5 HP | Bldg. 590 | 1986 | 3.73 KW | 24 | 7 | 26 | | |
| HW Water Pump | 1 | Aurora # D 6466-2A<br>52 GPM, 32 ft head<br>3 HP | Bldg. 590 | 1986 | 2.24 KW | 24 | 7 | 26 | | |
| HW Boiler | 1 | AJAX # WG 525-S<br>381.8 MBH out | Bldg. 590 | 1986 | 525 MBH | 24 | 7 | 26 | | |
| Air Cooled Chiller | 1 | Dunham Bush, # ACDRO70A, 460 V<br>2 Comp. 63.5 RLA,<br>6 Cond. fans 1.5 HP ea., 66.5 tons | Bldg. 591 | 1986 | 91.86 KW | 24 | 7 | 26 | | |
| Chilled Water Pump | 1 | Aurora # D 6466<br>135 GPM, 42 ft head<br>5 HP | Bldg. 591 | 1986 | 3.73 KW | 24 | 7 | 26 | | |
| HW Water Pump | 1 | Aurora # D 6466-2A<br>55 GPM, 32 ft head<br>3 HP | Bldg. 591 | 1987 | 2.24 KW | 24 | 7 | 26 | | |
| HW Boiler | 1 | AJAX # WG 850-S<br>623.9 MBH out | Bldg. 591 | 1987 | 850 MBH | 24 | 7 | 26 | | |
| Chiller | 1 | Trane Centravac, # CVHE 250<br>centrifugal, 460 V, 145 AMPS<br>170 tons | Bldg. 592 | 1995 | 105 KW | 24 | 7 | 26 | | |
| Chilled Water Pump | 1 | Taco<br>15 HP | Bldg. 592 | 1987 | 11.19 KW | 24 | 7 | 26 | | |
| HW Water Pump | 1 | Aurora # 855 100 94<br>200 GPM, 60 ft head<br>5 HP | Bldg. 592 | 1987 | 3.73 KW | 24 | 7 | 26 | | |
| HW Boiler | 1 | AJAX # WGB 2750-S<br>2,037 MBH out | Bldg. 592 | 1987 | 2750 MBH | 24 | 7 | 26 | | |
| Cooling Tower | 1 | Marley<br>single speed, Approx. 20 HP motor | Bldg. 592 | 1988 | 14.91 KW | 24 | 7 | 26 | | |
| Condenser Pump | 1 | Taco, # FE4008E2H1F2<br>600 GPM, 65 ft head<br>15 HP | Bldg. 592 | 1987 | 11.19 KW | 24 | 7 | 26 | | |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GORGAS CIRCLE
GUEST HOUSE
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1019P
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1005
1004
1003
1052
STANLEY ROAD
DICKMAN ROAD
592
BOQ
MEDICAL
MUSEUM
1046
N

AREA 1000

## BUILDING DESCRIPTION

NAME: Building 1000 & 1088

USE: Brooke Army Medical Center - hospital (emergency care, general surgery, radiology, labor & delivery/neonatal, chapel, administration, and kitchen/dining). Continuous occupancy twenty four (24) hours a day and seven (7) days a week.

GROSS AREA (SQ.FT.): 227,302 STORIES: 7 DATE OF SURVEY: 10/25/95

DATE OF CONSTRUCTION: 1930's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Flat, built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet and vinyl coated tile

CEILINGS: 2'/4' acoustical tile

WINDOWS: Operable, single pane, single hung, clear glass

COOLING EQUIP: Four-pipe, multi-zone and single-zone AHU's and two-pipe and four-pipe FCU's are distributed throughout the building. Three (3) primary fresh air units provide 100% outside air to 492 FCU's (original convertors are three-speed with replacement convertors single speed) scattered throughout the building. Air-side equipment is served by two (2) centrifugal chillers in bldg. 1088 that are piped in parallel and operate year round. Each of the chillers are controlled locally to maintain CHW supply setpoint. However, the chillers are not currently sequenced together but are manually shut on and off. The two chillers are served by two (2), single speed cooling towers with manual 3-way bypass. See HVAC Equipment Lists for details.

HEATING EQUIP: All of the AHU's and FCU's that have heating are supplied by three (3) HW boilers (one stand-by) located in the boiler plant behind the hospital. Each boiler has a low fire/ high fire according to the HW return temperature setpoint of 150°F. Also, these boilers operate year round, and have a dedicated HW pump. Three (3) low pressure steam boilers (LPS), 1 stand-by, are located in the hospital subbasement and provide heating for the radiators located throughout the building. These low pressure steam boilers are operated seasonally and are manually shut down. See HVAC Equipment Lists for details.

LIGHTING: Recessed, 2 & 4-lamp fixtures throughout hospital with incandescent fixtures in mechanical rooms.

DOMESTIC WATER HEATING: Two high pressure steam boilers (HPS-60 lb.) with only one firing rate provide steam for DHW generators. These boilers operate year round and provide

steam for sterilization, kitchen equipment, and humidification. DHW generators are located in the subbasement of the hospital.

OTHER: Two (2) primary CHW pumps in chiller plant. Nine (9) secondary CHW pumps not operating. Three (3) HW pumps in boiler plant. Ventilation fans are located in the subbasement and the chiller plant.

REMARKS: Chillers were installed in 1991 and appear in good condition. Both chillers were operating at part load. Each chiller is equipped with dedicated CHW and CND pumps. Some of the CHW piping throughout building was replaced in 1979, the rest is original. Chillers are maintained by base DPW, while boilers are maintained by hospital DPW. Nine (9) secondary CHW pumps located in the subbasement of the hospital were not operating even though several of the pumps were still in the loop. It appears that the primary pumps are capable of handling the distribution head. Two HW boilers operate according to hospital procedure, but one appears to handle the load. HPS and LPS piping is original with many leaks and has asbestos insulation.

## BUILDING DESCRIPTION

NAME: Building 1001

USE: Medical Library, Patient Transport Services, Endocrinology Clinic, Environmental Health, Occupational Health Clinic, Community Health Nursing, Social Work Service, Adolescent Med. Service, Dept. of Ministry/Pastoral Care. Continuous Occupancy between 7:30 A.M. and 5:00 P.M. with the exception of the library which is available 24 hours a day if needed.

GROSS AREA (SQ.FT.): 38,202 STORIES: 4 DATE OF SURVEY: 10/19/95

DATE OF CONSTRUCTION: 1936

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet and original Parquet wood

CEILINGS: Acoustical tile

WINDOWS: Single pane, operable, clear glass

COOLING EQUIP: Four-pipe, 10, 7.5, and 5 HP multi-zone (four zones) AHU's with wild CHW coils and two-way controlled steam coils serve first through third floors respectively. Fourth floor is served by 5 HP, four-pipe, single zone, AHU with face and bypass control, wild CHW coil, and a two-way steam coil which is located in the attic. The occupied areas in the basement are served by window units. These AHU's are served by centrifugal chiller and CHW pump located in the basement of bldg. 1002. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by one (1) low pressure steam boiler in the basement. This boiler has one firing rate and also serves restroom and entry vestibule radiators. See HVAC Equipment Lists for details.

LIGHTING: 10', 2-lamp, surface mounted and 2'/4' 2-lamp recessed fluorescent fixtures in most rooms; 4', 1-lamp fluorescent fixtures in corridors.

DOMESTIC WATER HEATING: One (1) 91 gallon, gas fired DHW heater is piped into storage tank located in basement.

OTHER: One (1) condensate return unit. One (1) ventilation fan in mechanical room.

REMARKS: Return air for building is from plenum space above ceilings into the mechanical rooms which serve as plenum. Two other steam boilers are located in basement but they are not used. All mechanical rooms have min/max outside air dampers and pneumatic controls. First floor AHU blower appears to be undersized to condition the air for the entire floor. No DHW pump.

## BUILDING DESCRIPTION

NAME: Building 1029

USE: Brooke Army Medical Center Headquarters - Admin, optical lab, mailroom. Continuous occupancy of approximately 100 people between 7:00 A.M. and 5:00 P.M.

GROSS AREA (SQ.FT.): 51,236 STORIES: 4 DATE OF SURVEY: 10/25/95

DATE OF CONSTRUCTION: 1936

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and stone

ROOF: Pitched roof with clay tile

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet and vinyl coated tile

CEILINGS: 2'/2' and 2'/4' acoustical tile

WINDOWS: Single pane, single hung, operable, clear glass

COOLING EQUIP: Basement through the third floor is served by four-pipe, 5 HP, single zone, AHU with three-way controlled CHW and HW coils and a face and bypass section. Fourth floor is served by a similar type of unit but has a 3 HP motor, and does not have face and bypass control. A temperature controller modulates the CHW and HW control valves and the face and bypass dampers to maintain space temperature. AHU's do have economizer control but has been de-activated. Optical lab located in basement has DX coil, packaged, AHU's. Centrifugal chiller is located in basement mechanical room and the 2-speed cooling tower, with no bypass, is located on the roof. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by one (1) water tube HW boiler in boiler room. This boiler has no primary bypass loop and has two firing rates. See HVAC Equipment Lists for details.

LIGHTING: 2'/4' 2-lamp recessed fluorescent fixtures in most rooms; 2'/2' u-tube fluorescents in the newly renovated first floor..

DOMESTIC WATER HEATING: One (1) 75 gallon, gas fired DHW heater located in boiler rm.

OTHER: One (1) CHW pump, CND pump, and HW pump. One (1) exhaust fan serves restrooms. Two (2) ventilation fans in chiller room.

REMARKS: Chiller, CHW pump, CND pump in basement are six months old. Controls on the units are in poor condition. Economizer control on AHU's is not working. Elevator room adjacent to classroom on top floor has no ventilation except through louver in door separating the two rooms.

PROPOSED HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1000
MARCH 1, 1996

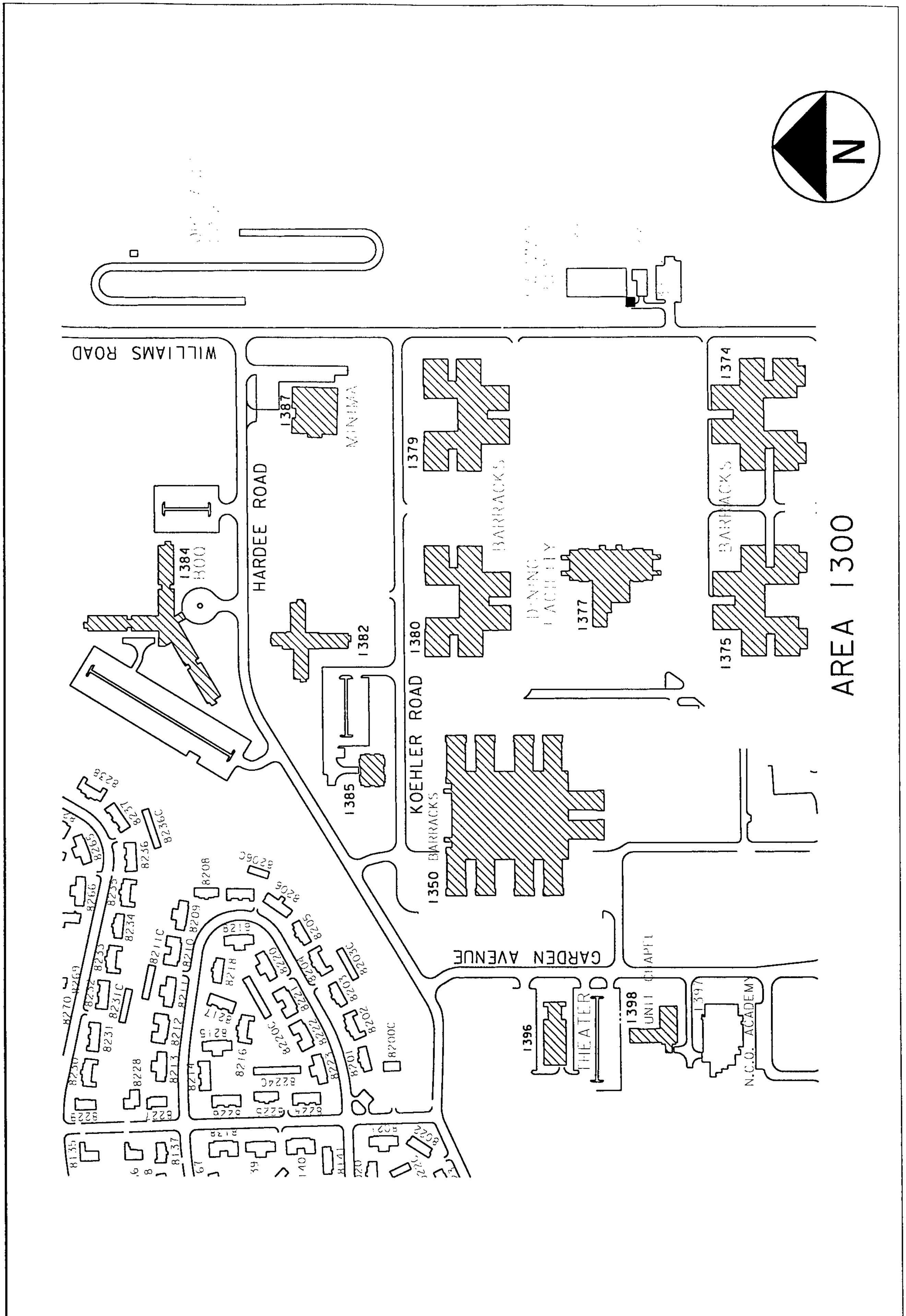
| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Chiller # 1 | 1 | York (centrifugal)<br># YTG3H3E1CND, R-11<br>FLA-316, Volts-460, 400 tons | Bldg. 1000 | 1993 | 252 KW |
| Chilled Water Pump | 1 | TACO, 50 HP<br>960 GPM, 100 ft head | Bldg. 1000 | 1993 | 37.29 KW |
| Cond. Water Pump | 1 | TACO, 40 HP<br>1132 GPM, 66 ft head | Bldg. 1000 | 1993 | 29.83 KW |
| Cooling Tower | 1 | Marley, 25 HP<br>single speed motor | Bldg. 1000 | 1993 | 18.64 KW |
| Chiller # 2 | 1 | York (centrifugal)<br># YTG3H3E1CND, R-11<br>FLA-316, Volts-460, 400 tons | Bldg. 1000 | 1993 | 277 KW |
| Chilled Water Pump | 1 | TACO, 50 HP<br>960 GPM, 100 ft head | Bldg. 1000 | 1993 | 37.29 KW |
| Cond. Water Pump | 1 | TACO, 40 HP<br>1132 GPM, 66 ft head | Bldg. 1000 | 1993 | 29.83 KW |
| Cooling Tower | 1 | Marley, 25 HP<br>single speed motor | Bldg. 1000 | 1993 | 18.64 KW |
| HW Boiler | 1 | Bryan, # K550WGT, high/low fire rate<br>5000/2500 MBH, 120 HP, flex tube<br>20 f, delta t, 4230 MBH out | Bldg. 1000 | 1992 | 5,500 MBH |
| HW Pump | 1 | TACO # 1030 4x5x12, 25 HP<br>400 GPM, head unknown (90ft. approx.) | Bldg. 1000 | 1992 | 18.64 KW |
| HW Boiler | 1 | Bryan, # K550WGT, high/low fire rate<br>5000/2500 MBH, 120 HP, flex tube<br>20 f, delta t, 4230 MBH out | Bldg. 1000 | 1992 | 5,500 MBH |
| HW Pump | 1 | TACO # 1030 4x5x12, 25 HP<br>400 GPM, head unknown (90ft. approx.) | Bldg. 1000 | 1992 | 18.64 KW |
| HW Boiler (Stand-by) | 1 | Bryan, # K550WGT, high/low fire rate<br>5000/2500 MBH, 120 HP, flex tube<br>20 f, delta t, 4230 MBH out | Bldg. 1000 | 1992 | 5,500 MBH |

PROPOSED HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1000
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| HW Pump (Stand-by) | 1 | TACO # 1030 4x5x12, 25 HP<br>400 GPM, head unknown (90ft. approx.) | Bldg. 1000 | 1992 | 18.64 KW |
| Low Pressure Boiler | 1 | Kewanee # 5139<br>Fire tube, 15 psig.<br>3072 MBH out | Radiator heaters<br>Bldg. 1000 | 1950 | 5,223 MBH |
| Condensate Ret. Pump | 1 | 0.5 HP. 2 each | Bldg. 1000 | 1988 | 0.37 KW |
| Low Pressure Boiler | 1 | Kewanee # 5139<br>Fire tube, 15 psig.<br>3072 MBH out | Radiator heaters<br>Bldg. 1000 | 1950 | 5,223 MBH |
| Condensate Ret. Pump | 1 | 1.5 HP. 2 each | Bldg. 1000 | 1988 | 1.12 KW |
| Low Pressure Boiler | 1 | Kewanee # 5139<br>Fire tube, 15 psig.<br>3072 MBH out | Radiator heaters<br>Bldg. 1000 | 1950 | 5,223 MBH |
| Condensate Ret. Pump | 1 | 2 HP. 2 each | Bldg. 1000 | 1988 | 1.49 KW |
| Sec. Chilled Water Pumps | 9 | Various sizes, 1 HP to 7.5 HP<br>*these pumps are not operated, but CHW is supplied through them.* | Bldg. 1000 | 1980 | N/A |
| Steam Boiller | 1 | Richmond Heatomat, BO3, 15 psig<br>*not operating*<br>894 MBH out | Bldg. 1001 | 1975 | 1,260 MBh |
| Steam Boiller | 1 | Richmond Heatomat, BO2, 15 psig<br>*not operating*<br>521.5 MBH out | Bldg. 1001 | 1975 | 735 MBH |
| Steam Boiller | 1 | AJAX, SGX-1050-S, BO1<br>15 psig.<br>761.9 MBH out | Bldg. 1001 | 1975 | 1,050 MBH |
| Condensate Ret. Pump | 1 | Dunham - Bush<br>1 HP | Bldg. 1001 | 1994 | 0.75 KW |
| Window Units | 4 | 19,000 BTUH clg. & 17,300 BTUH htg.<br>9 EER | Bldg.1001 Basement | 1985 | 8.4 KW |

PROPOSED HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1000
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Chiller | 1 | Trane, # PVC-2001D2, R-11<br>460 V, 257 FLA<br>219 tons | Bldg. 1001 & 1002 | 1974 | 209.1 KW |
| Cooling Tower | 1 | Marley, # NC2021GM044049-001<br>15 HP | Bldg. 1001 & 1002 | 1974 | 11.19 KW |
| CHW Pump | 1 | Aurora<br>520 GPM, 75 ft. head, 15 HP | Bldg. 1001 & 1002 | 1974 | 11.19 KW |
| Cond. Pump | 1 | Aurora<br>640 GPM, 65 ft. head, 15 HP | Bldg. 1001 & 1002 | 1974 | 11.19 KW |
| Chiller | 1 | Trane, Centravac, # CVHE250<br>460 V, 137 RLA, R-123<br>160 tons | Bldg. 1029 | 1995 | 100 KW |
| Cond. Pump | 1 | TACO<br>860 GPM, 96 ft. head<br>25 HP | Bldg. 1029 | 1995 | 18.64 KW |
| CHW Pump | 1 | TACO # FE3013E2MIGLOA<br>25 HP | Bldg. 1029 | 1995 | 18.64 KW |
| Cooling Tower | 1 | Marley<br>2 speed fan 10/2.5 HP | Bldg. 1029 | 1995 | 7.46 KW<br>4.36 KW |
| HW Boiler | 1 | Rite Heating Boilers<br># 250, No OA temp. reset, or 3-way valve<br>1887 MBH out | Bldg. 1029 | 1990 | 2,500 MBH |
| HW Pump | 1 | Bell & Gosset<br>200 GPM, 37 ft head<br>3 HP | Bldg. 1029 | 1990 | 2.24 KW |
| Air Cooled Cond. | 1 | Rudd, # UAWB-100CA5<br>208 V, 42.3 RLA, cond fans 2 ea. 2.0 FLA<br>*not included in model* | Optical lab<br>Bldg. 1029 | N/A | N/A |
| Air Cooled Cond. | 1 | Mc Quay # ST010A1S11<br>208 V, 42 RLA, cond. fans 2 ea. 0.5 HP<br>*not included in model* | Optical lab<br>Bldg. 1029 | N/A | N/A |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HARDEE ROAD
KOEHLER ROAD
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BOQ
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1375
1377
1350
BARRACKS
1396
THEATER
1398
UNIT CHAPEL
1397
N.C.O. ACADEMY

## BUILDING DESCRIPTION

NAME: Building 1350

USE: Barracks, administrative offices, dining and classrooms for single enlisted personnel. Maximum occupancy of 800 persons with current occupancy of 1550 personnel.

GROSS AREA (SQ.FT.): 261,406 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1983

STRUCTURE: Masonry

EXTERIOR WALLS: Both brick and precast panel.

ROOF: Flat built-up roof.

FLOOR CONSTRUCTION: Slab on grade

FLOOR FINISH: Concrete topping, tile, and carpet

CEILINGS: Lay in acoustical tile, plaster, and stucco

WINDOWS: Single pane with glazed, insulating glass.

COOLING EQUIP: Seven central multi-zone, variable volume air handling units with three-way controlled CHW and HW coils serve most of the building. Four of the AHU's have 30 HP motor's, with three other's having a 15, 20, and 25 HP motor each. Temperature controller modulates control valves on HW and CHW coils to maintain leaving air temperature. Space thermostats control zone dampers, and economizer cycle for AHU's has been de-activated. Approximately 20 two-pipe fan coil units serving cadre rooms. All units are served by central chillers in building 1377.

HEATING EQUIP: See cooling equipment above. Multiple heating/ventilating units serving scrub rooms, toilets and kitchen areas along with heating water convection units serving multiple areas throughout building. All units are served by central boilers in building 1377.

LIGHTING: Lay-in fluorescent fixtures in barracks, admin, classrooms, and dining areas. Surface mounted fluorescent fixtures in kitchen and scattered incandescent fixtures.

DOMESTIC WATER HEATING: Gas fired hot water heaters in building to serve restrooms.

OTHER: 7 ½, ½, ½ HP heating water pumps in building. Steam boilers in building serve kitchen equipment.

REMARKS: Poor temperature control, extremely hot during field survey. Piping leaks are a problem. All other HVAC systems appeared to be in fair condition.

## BUILDING DESCRIPTION

NAME: Buildings 1374, 1375, 1379, 1380

USE: Barracks for single enlisted personnel, classrooms and administrative offices. Maximum occupancy of approximately 475 people.

GROSS AREA (SQ.FT.): 111,448 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1971

STRUCTURE: Partially exposed structural steel frame

EXTERIOR WALLS: Brick and stucco veneer

ROOF: built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: concrete topping and carpet

CEILINGS: Lay-in acoustical tile in building with stucco over exposed areas

WINDOWS: single pane clear and tempered glass

COOLING EQUIP: Approximately six, 7.5 HP multi-zone, constant volume central AHU's with three-way controlled HW coil and a wild CHW coil serve barracks and office areas of the buildings. Temperature controller modulated HW control valve to maintain leaving coil air temperature setpoint, and space thermostat controls zone dampers. Unit also has economizer control but it has been de-activated. Approximately four cabinet type fan coil units serving classrooms in the buildings. All units served by central chillers in building 1377.

HEATING EQUIP: See cooling equipment above. All units served by central boilers in building 1377.

LIGHTING: Surface mounted incandescent fixtures in exposed areas. Lay-in fluorescent fixtures in admin and barracks areas.

DOMESTIC WATER HEATING: Gas fired hot water boilers in building to serve restrooms.

OTHER: Secondary 7 ½ and 5 HP chilled/heating water pumps in building.

REMARKS: Poor temperature control, extremely hot during field survey. Renovations to building has caused restricted return air flow back to air handling units. All other HVAC systems appeared to be in fair condition.

**BUILDING DESCRIPTION**

NAME: Building 1377

USE: Kitchen and dining hall in building. Other areas serve as central chiller and boiler plant for buildings in 1300 area. Maximum occupancy of 800 persons on weekdays between 4 am and 9 pm.

GROSS AREA (SQ.FT.): 30,350 STORIES: 1 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1971

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Sloped built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile, gypsum wallboard, and plaster

WINDOWS: single pane clear glass

COOLING EQUIP: Dining areas served by two, 5 HP, single zone air handlers with three-way controlled HW and CHW coils, and face and bypass dampers. Return air temperature is controlled by modulating CHW and HW control valves along with face and bypass dampers to maintain setpoint. Mixed air temperature is maintained at setpoint by modulating return and outside air dampers when outside air dry bulb temperature falls below 68°F. Air handler cooling coils served by central chiller in building 1377. Kitchen served by two, 3 HP evaporative coolers which are controlled manually by three position switch located in kitchen (vent, cool, heat).

HEATING EQUIP: See cooling equipment above. Air handler heating coil served by central boiler in building 1377. Evaporative coolers serving kitchen have steam htg.. coil which is supplied by steam boiler in building 1377.

LIGHTING: Surface mounted fluorescent fixtures

DOMESTIC WATER HEATING: Electric hot water heater in building to serve restrooms.

OTHER: Central chiller and boiler equipment, see HVAC Equipment List for descriptions along with steam boiler to serve bldg. 1377 kitchen equipment.

REMARKS: Poor temperature control, extremely hot during field survey. All mechanical systems appeared to be in a deteriorated state, particularly the HVAC controls and piping insulation. Exhaust fans appeared to operate while central AHUs were off. Return air grilles appeared to be excessively dirty.

## BUILDING DESCRIPTION

NAME: Building 1382

USE: Barracks for single enlisted personnel, administrative offices. Continuous occupancy of approximately 240 persons.

GROSS AREA (SQ.FT.): 29,390 STORIES: 2 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1971

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Flat Built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Gypsum wallboard and acoustical tile

WINDOWS: Single pane clear glass

COOLING EQUIP: Building served by two (2) central, 4-pipe, 5 HP, multi-zone AHU's with three-way controlled CHW and HW coils. Air handler cooling coils served by central chillers in building 1377.

HEATING EQUIP: See cooling equipment above. Air handler heating coils served by central boilers in building 1377.

LIGHTING: Surface and suspended mounted fluorescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heaters in building to serve restrooms.

OTHER: Secondary 3/4 HP chilled water and ½ HP heating water pumps in building.

REMARKS: Poor temperature control, extremely hot during field survey. All other HVAC systems appeared to be in fair condition. Outside air intake louvers have been blanked off with sheet metal, reducing HVAC loads but also reducing indoor air quality. Building may not meet ASHRAE standards for ventilation.

## BUILDING DESCRIPTION

NAME: Building 1384

USE: Unlisted Personnel Housing (UPH) - Transient Lodging Facility. Current occupancy of 300 people with one person per room.

GROSS AREA (SQ.FT.): 145,420 STORIES: 5 DATE OF SURVEY: 10/18/95

DATE OF CONSTRUCTION: N/A

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and precast concrete

ROOF: Flat built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: Operable, single pane clear glass

COOLING EQUIP: Five, 20 HP, multi-zone (seven zones on first floor and six zones on 2-5 floors) AHU's with wild CHW coil and three-way controlled HW coil are located on each floor. Controller modulates HW valve to maintain leaving coil temperature setpoint, and space thermostats control zone dampers. AHU's also have economizer control but it has been de-activated. AHU's served by an R-11 centrifugal chiller and one cell, single speed cooling tower in central plant.

HEATING EQUIP: AHU's served by water tube HW boiler in central plant that does have hot water reset control. HW boiler has three way control on primary side.

LIGHTING: Recessed 4-lamp fluorescent fixtures with electronic ballast and T-8 lamps.

DOMESTIC WATER HEATING: 1,650 MBH DHW boiler provides 170°F water to heat exchanger. Primary pump is controlled by setpoint of leaving shell water temperature setpoint of 128°F. As secondary loop circulated DHW from the heat exchanger to a DHW storage tank. A third building loop circulated the water from the tank out through the building.

OTHER: DHW primary, secondary, and building pumps, CHW and HW pumps, bldg. exhaust fan. Secondary 1/4 HP chilled water and 1/8 HP heating water pumps in building.

REMARKS: AHU's do have economizer capabilities but outside air dampers have been de-activated. AHU's have vertical roll filters. 112.5 KVA transformer located in mechanical room plenum space on each floor except the first. HW boiler has dual fire capabilities with diesel being the second fuel. DHW boiler has a tremendous amount of heat loss to the mechanical room space. A new CHW pump was to replace the existing. DHW boiler has draft inducer fan. Kitchen in

lounge has no make-up air for exhaust fans. Controllers have recently been upgraded from pneumatics to electronics. Mechanically, this building is almost identical to Building 592 with the exception of the size and age of the equipment.

## BUILDING DESCRIPTION

NAME: Building 1385

USE: Administrative services for 232nd Medical Battalion troops. Continuous occupancy of approximately 22 persons.

GROSS AREA (SQ.FT.): 5,072 STORIES: 1 DATE OF SURVEY: 11/30 to 12/2/94

DATE OF CONSTRUCTION: 1971

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Flat built-up roof

FLOOR CONSTRUCTION: Slab on grade

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile and gypsum wallboard

WINDOWS: Single pane clear glass

COOLING EQUIP: Building served by one (1) 4-pipe, 3 HP, multi-zone AHU with three-way controlled HW and CHW coils. Air handler cooling coil served by central chiller in building 1377.

HEATING EQUIP: See cooling equipment above. Air handler heating coil served by central boiler in building 1377.

LIGHTING: Recessed and surface mounted fluorescent fixtures in office areas and surface mounted incandescent fixtures in other areas

DOMESTIC WATER HEATING: Electric, 66 gallon DHW heater in building to serve restrooms.

OTHER: Secondary 1/4 HP chilled water and 1/8 HP heating water pumps in building.

REMARKS: Poor temperature control, extremely hot during field survey. All other HVAC systems appeared to be in fair condition. Outside air intake louvers have been blanked off with sheet metal, reducing HVAC loads but also reducing indoor air quality. Building may not meet ASHRAE standards for ventilation.

## BUILDING DESCRIPTION

NAME: Building 1387

USE: Minimall - grocery, laundry, retail, snack bar, and salon. Continuous occupancy of approximately 20 full-time staff and 200 students between 11:00 A.M. and 8:00 P.M.

GROSS AREA (SQ.FT.): 15,080 STORIES: 1 DATE OF SURVEY: 10/18/95

DATE OF CONSTRUCTION: 1988

STRUCTURE: Masonry facade

EXTERIOR WALLS: Brick

ROOF: Sloped single-ply roof on metal deck

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: vinyl coated tile

CEILINGS: Acoustical tile

WINDOWS: Single pane insulated glass

COOLING EQUIP: Five split system, DX, heat pumps with horizontal and floor mounted AHU's. The AHU motors vary from 15 HP down to 1-1/2 HP. All AHU's except AHU-5 have economizer cycles.

HEATING EQUIP: See cooling equipment above. AHU's have supplemental resistance heat.

LIGHTING: Recessed fluorescent fixtures in snack bars, grocery, salon, and jewelry. Downlights in lobby area.

DOMESTIC WATER HEATING: 50 gallon domestic hot water heater serving kitchen area.

OTHER:

REMARKS: There is limited occupancy until 5 P.M. Poor temperature control. This building is maintained and operated by AAFES instead of DPW. Fire control is integrated into the building mechanical systems.

## BUILDING DESCRIPTION

NAME: Building 1396

USE: Evan's Theater - used for shows and classroom. Maximum occupancy of 490 people with 50% capacity year round between the hours of 8:00 A.M. and 12:00 P.M.

GROSS AREA (SQ.FT.): 11,805 STORIES: 1 DATE OF SURVEY: 10/18/95

DATE OF CONSTRUCTION: 1971

STRUCTURE: Masonry facade

EXTERIOR WALLS: Brick and precast concrete

ROOF: Flat built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Tile, wood, and terrazzo

CEILINGS: Acoustical tile, plaster, and stucco

WINDOWS: single pane clear glass

COOLING EQUIP: One (1) packaged, reciprocating, 7.5 HP, single zone, DX unit serves the auditorium and is located in mechanical room. This unit rejects it heat to a condenser water loop from an air cooled condenser located outside. A second 5 HP, DX air handling unit located in mechanical room adjacent to the lobby serves the lobby/office area and is served by a split system condensing unit located on the roof of the first floor lobby. See HVAC Equipment Lists for details.

HEATING EQUIP: Water tube HW boiler (160°F supply temperature) provides HW for two (2) duct mounted heating coils, one for each unit.

LIGHTING: Twenty-six 400 W metal halide fixtures in auditorium, and incandescents in office.

DOMESTIC WATER HEATING: 75 gallon , gas fired, DHW heater without pump in main mechanical room.

OTHER: Three HW pumps (one stand-by) serve two duct mounted coils. Thermostat cycles HW pumps on and off. Exhaust fan for restrooms located on the roof.

REMARKS: None of the HW piping in the mechanical room is insulated. Building is mostly used for classroom space.

## BUILDING DESCRIPTION

NAME: Building 1398

USE: AMEDDC Chapel - administration offices and chapel. Maximum occupancy of 350 people with two (2) services on Sunday approximately 75% full. Three miscellaneous services during the week with an average of 50 people. Continuous occupancy of five (5) people in the administration wing between 7:30 A.M. and 5:00 P.M. on the weekdays.

GROSS AREA (SQ.FT.): 8,006 STORIES: 1 DATE OF SURVEY: 10/18/95

DATE OF CONSTRUCTION: 1972

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Sloped built-up roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Acoustical tile

WINDOWS: operable, single pane clear glass

COOLING EQUIP: Twenty-one (21) 2-pipe, 1/8 HP FCU's with pneumatic mixing valves and thermostats are served by hermetic reciprocating chiller in mechanical room and air cooled condenser outside. See HVAC Equipment Lists for details.

HEATING EQUIP: Above air-side equipment is served by water tube HW boiler with hot water reset capabilities but de-activated.

LIGHTING: Incandescent downlights in chapel. Surface mounted fluorescent fixtures in administration wing.

DOMESTIC WATER HEATING: 30 gallon, gas fired, DHW heater without pump in main mechanical room.

OTHER: Mechanical room ventilation fan

REMARKS: Manual changeover valves are in mechanical room. Filters were installed backwards. One chiller serves the chapel and the administration. Therefore, it is running at low load much of the time which is very inefficient. 2-pipe switch-over is manual but the original intent of the design was for it to be automatic.

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1300
MARCH 1, 1996

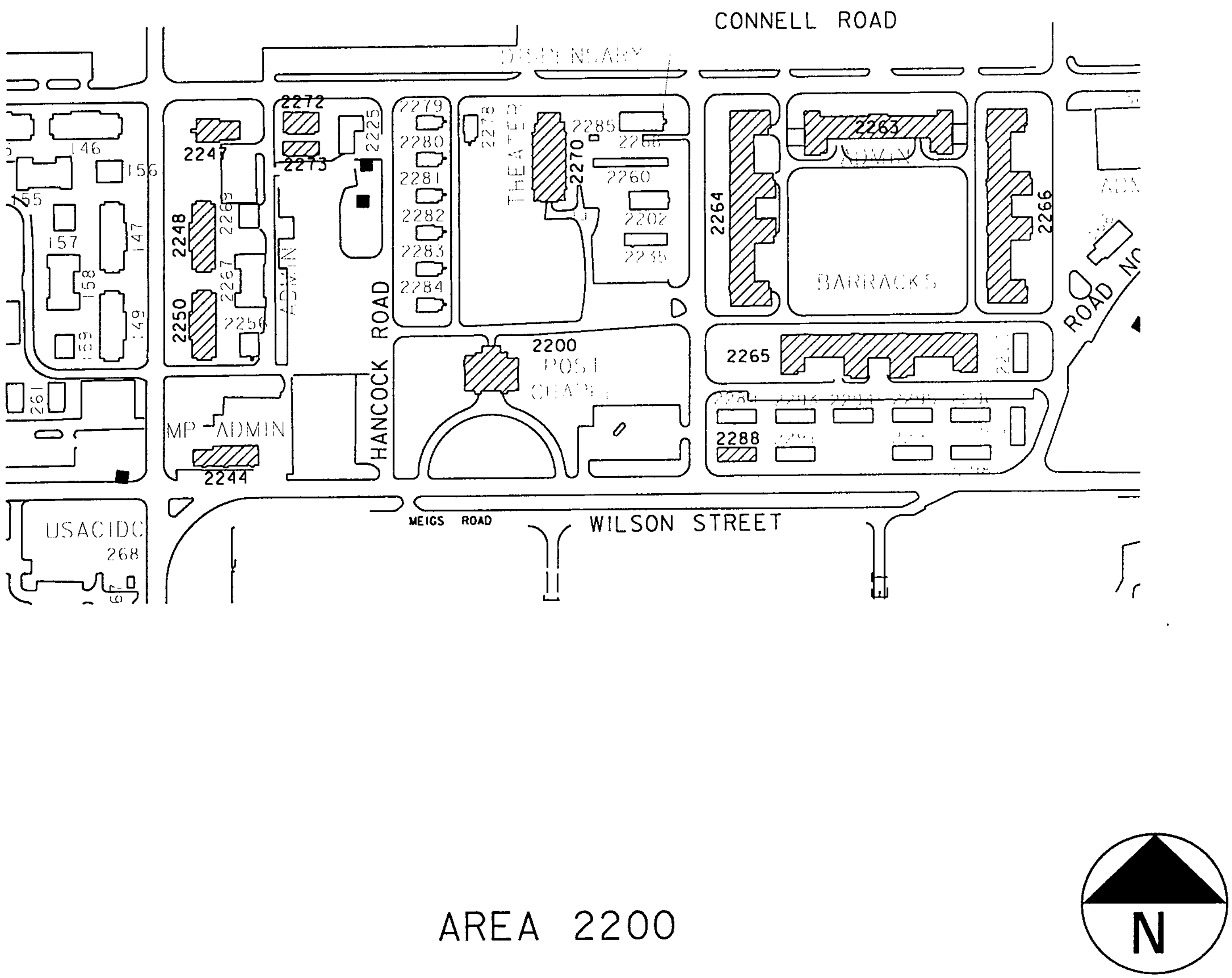
| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Water Chiller | 1 | Trane #PCV-5F-C1D1<br>water cooled, centrifugal,<br>544 tons, R-11 | Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385 | 1972 | 517 KW |
| Water Chiller | 1 | Trane #PCV-5F-C1D1<br>water cooled, centrifugal,<br>442 tons, R-11 | Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385 | 1972 | 517 KW |
| Water Chiller | 1 | Carrier #19DK 78942P<br>water cooled, centrifugal,<br>438 tons, R-11 | Bldg. 1350 | 1983 | 334.5 KW |
| Chilled Water Pump | 2 | Aurora<br>870 gpm, 79 ft<br>25 HP | Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385 | 1972 | 18.65 KW |
| Chilled Water Pump | 1 | Allis Chalmers<br>775 gpm, 114 ft<br>40 HP | Bldg. 1350 | 1983 | 29.84 KW |
| Condenser Water Pump | 2 | Aurora<br>1440 gpm, 70 ft<br>40 HP | Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385 | 1972 | 29.84 KW |
| Condenser Water Pump | 1 | Allis Chalmers<br>1314 gpm, 30 ft<br>30 HP | Bldg. 1350 | 1983 | 22.38 KW |
| Cooling Tower | 1 | Marley #324T<br>induced draft,<br>2-35 HP fans | Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385 | 1972 | 52.22 KW |
| Cooling Tower | 1 | Marley<br>induced draft,<br>20 HP fan | Bldg. 1350 | 1983 | 14.92 KW |
| Hot Water Boiler | 2 | C.B. #CB700X-200<br>10 HP forced draft,<br>5912 MBH output | Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385 | 1972 | 8,369 MBH<br>7.46 KW |
| Hot Water Boiler | 1 | Rite #A750WG<br>natural draft, watertube<br>5317 MBH output | Bldg. 1350 | 1983 | 7,500 MBH |
| Hot Water Boiler | 1 | Ajax #WGB 9500<br>natural draft, watertube<br>4336 MBH output | Bldg. 1350 | 1983 | 5,800 MBH |
| Heating Water Pump | 2 | Aurora<br>443 gpm, 76 ft<br>15 HP | Bldgs. 1374, 1375, 1379, 1380, 1382, 1377, 1385 | 1972 | 11.19 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1300
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Heating Water Pump | 1 | Allis Chalmers<br>134 ft<br>40 HP | Bldg. 1350 | 1983 | 29.84 KW |
| Chiller | 1 | Trane, Centravac, # PCV2HC2D2<br>460 V, 311 RLA, R-11<br>273 tons | Bldg. 1384 | 1973 | 251 KW |
| Chilled Water Pump | 1 | Aurora # 723-10408, 15 HP<br>665 GPM, 65 ft head | Bldg. 1384 | 1995 | 11.19 KW |
| Cond. Water Pump | 1 | Aurora # 93E-15820, 20 HP<br>819 GPM, 50 ft head | Bldg. 1384 | 1973 | 14.9 KW |
| Cooling Tower | 1 | Marley, 20 HP, #05196-00-93<br>single speed motor<br>Model # NC3021GM | Bldg. 1384 | 1993 | 14.9 KW |
| HW Boiler | 1 | AJAX # WGOFD-5000<br>3636 MBH out | Bldg. 1384 | 1986 | 5000 MBH |
| HW Pump | 1 | Aurora, # 93E16061<br>265 GPM, 60 ft. head<br>7.5 HP | Bldg. 1384 | 1986 | 5.59 KW |
| Condensing Unit | 2 | Carrier heat pump<br># 38AQ-016-5W, 208V, 63.6 RLA<br>Cond fans 2 ea. 1 ph. 4.0 AMP/fan | Bldg. 1387 | 1988 | 55.73 KW |
| Condensing Unit | 1 | Carrier heat pump<br># 38QH024300, 208V, 14.5 RLA<br>Cond fans 1 ea. 1/8 HP | Bldg. 1387 | 1988 | 5.74 KW |
| Condensing Unit | 2 | Carrier heat pump<br># 38AQ-012-510, 208V, 43.6 RLA<br>Cond fans 2 ea. 1 ph. 4.0 AMP/fan | Bldg. 1387 | 1988 | 37.04 KW |
| Condensing Unit | 2 | Carrier heat pump<br># 38AQ-024-----, 208V, 63.6 RLA<br>Cond fans 3 ea. 1 ph. 4.5 AMP/fan | Bldg. 1387 | 1988 | 54.75 KW |
| DX Packaged AHU | 1 | Trane, # 5A403C<br>208 V , 140 RLA<br>7.5 HP fan, 50 tons | Bldg. 1396 | 1975 | 63.17 KW |
| HW Pump For RH Coils | 2 | TACO<br>1/4 HP<br>one stand-by, other serves pack. AHU | Bldg. 1396 | 1975 | 0.19 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 1300
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| HW Boiler | 1 | Thermopak<br># GAW-602<br>427.1 MBH out | Bldg. 1396 | 1986 | 602 MBH |
| HW Pump For RH Coils | 1 | TACO<br>1/4 HP<br>serves split system AHU | Bldg. 1396 | 1975 | 0.19 KW |
| Air Cooled Condenser | 1 | Trane, # CA 4008<br>5 HP | Bldg. 1396 | 1980 | 3.73 KW |
| Air Cooled Condensing unit | 1 | Rudd, # UAWC075AS<br>230 V, 24.8 RLA, Cond fan 1/3 HP<br>7.5 ton | Bldg. 1396 | 1988 | 10.94 KW |
| Air Cooled Cond. | 1 | Trane, # CA 6008<br>7.5 HP | Bldg. 1398 | 1980 | 5.59 KW |
| CHW/HW Pump | 1 | Aurora<br>104 GPM, 80 ft. head, 5 HP | Bldg. 1398 | 1975 | 3.73 KW |
| Chiller | 1 | Trane, # CG50D<br>230 V, 91.3 RLA<br>43.6 tons | Bldg. 1398 | 1975 | 55.1 KW |
| HW Boiler | 1 | AJAX WG525-S<br>381.8 MBH out | Bldg. 1398 | 1986 | 525 MBH |



CONNELL ROAD
DISPENSARY
THEATER
BARRACKS
ADMIN
POST CHAPEL
MP ADMIN
HANCOCK ROAD
MEIGS ROAD
WILSON STREET
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AREA 2200

## BUILDING DESCRIPTION

NAME: Building 2200

USE: Post Chapel. Maximum occupancy of 550 people in the main sanctuary which is occupied at 80% occupancy once a week on Sundays. The side wings are occupied on an average of once a week.

GROSS AREA (SQ.FT.): 21,536 STORIES: 1 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1940's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick and precast concrete

ROOF: flat built-up and cooper roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: N/A

WINDOWS: Single pane clear glass.

COOLING EQUIP: Four single zone AHU's with three-way controlled CHW and HW coils. Two (2) are located in the mezzanine and serve the chapel and the other two (2) are located in the basement and serve the music room and the basement conference room. Ten (10), 4-pipe FCU's serve the side sanctuary areas and the offices. This air-side equipment is served by an ACR chiller located adjacent to the central plant behind the Chapel.

HEATING EQUIP: Above air-side equipment is served by water tube boiler in central plant.

LIGHTING: 2-lamp fluorescent fixtures in offices and incandescents, fluorescents in auditorium.

DOMESTIC WATER HEATING: One (1) 30 gallon DHW heater in basement.

OTHER: CHW, HW pumps in central plant, ventilation fan in mechanical room.

REMARKS: This building has recently been renovated with new mechanical equipment. Air-side equipment in basement is difficult to access for maintenance.

## BUILDING DESCRIPTION

NAME: Building 2244

USE: Military Police Station. Continuous Occupancy of twelve (12) people between the hours of 7:00 A.M. and 6:00 P.M. and four (4) people between 6:00 P.M. and 7:00 A.M.

GROSS AREA (SQ.FT.): 4,672 STORIES: 1 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1940's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: 2'/2' Acoustical lay-in tile

WINDOWS: Single pane clear glass.

COOLING EQUIP: One (1) 3 HP, DX AHU with three-way controlled HW coil is located in mechanical room. Space thermostat modulates solenoid valve on DX coil or HW coil. AHU is served by one (1) condensing unit located on North side of building.

HEATING EQUIP: Above air-side equipment is served by one (1) gas fired boiler in mechanical room. Boiler is operated on (100%) and off by outside thermostat setpoint.

LIGHTING: Recessed 2-lamp fluorescent fixtures.

DOMESTIC WATER HEATING: One (1) 30 gallon DHW heater in mechanical room.

OTHER: One (1) in-line cartridge type HW pump in mechanical room.

REMARKS: This building operates the chiller water system year-round. Computer room in building is served by central AHU. Return air is through the corridors.

## BUILDING DESCRIPTION

NAME: Building 2247

USE: ARMY Learning Center - classroom, library, study. Continuous occupancy of eight (8) people between 7 A.M. and 7 P.M. and an additional 30 people for 3 hours/week for classes.

GROSS AREA (SQ.FT.): 8,872 STORIES: 1 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1936

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Lay-in acoustical tile

WINDOWS: single pane clear glass.

COOLING EQUIP: One (1) cooling only DX AHU with face and bypass control above restroom ceiling space is served by one open drive, DX, R-12 chiller and one (1) condenser outside.

HEATING EQUIP: Wall radiators located in library heat the entire building with the exception of the converted front porch area which is heated gas fired wall units. Radiators are served by steam boiler in basement.

LIGHTING: 2-lamp fluorescent fixtures in library without covers and recessed fluorescents scattered through building.

DOMESTIC WATER HEATING: Abandoned 30 gallon DHW heater in basement.

OTHER: CND pump in basement.

REMARKS: Boiler room occasionally floods from storm drain back-up. When boiler is operating, this can be a life safety problem which also damages the equipment including the boiler. Chiller constantly leaks refrigerant and there is no ventilation in room which is a code violation, not to mention life safety problem. AHU location is very difficult to access.

## BUILDING DESCRIPTION

NAME: Building 2248 & 2250

USE: Education Center, Provost Marshall, M.P. Investigations, AWOL Section, and Physical Security. Continuous occupancy of 35 people in both buildings between 8:00 A.M. and 5:00 P.M.

GROSS AREA (SQ.FT.): 13,716 STORIES: 2 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1936

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Lay-in acoustical tile and plaster

WINDOWS: Operable, single pane, clear glass.

COOLING EQUIP: Two (2) 4-pipe, 3 HP, single zone AHU's with face and bypass control, wild CHW and HW coils are located in each building. Space temperature setpoint is maintained by modulating face and bypass dampers. One AHU is located in basement and the other is located in the attic. Also, six, 1/16 HP FCU's (HW and CHW) serve the perimeter of the building. Both of these buildings are served by one ACR chiller located between the two buildings.

HEATING EQUIP: Above air-side equipment is served by one (1) water tube HW boiler that is located in the basement of bldg. 2248. This boiler has three-way control on the primary side to maintain HW supply temperature and it operates at 100% fire whenever on.

LIGHTING: Recessed 2-lamp fixtures, and suspended 2-lamp and 4-lamp fluorescent fixtures.

DOMESTIC WATER HEATING: 30 gallon DWH and tank in both buildings but they are not operating.

OTHER: Three CHW pumps with one (1) serving bldg 2250, and two serving bldg. 2248. Three HW pumps with one (1) serving Bldg. 2250, and the other two serving bldg. 2248.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Building 2248 appears to have balancing problem, and the second floor of bldg. 2250 has a temperature control problem.

## BUILDING DESCRIPTION

NAME: Building 2263

USE: Administrative offices for post fiscal activities. Maximum occupancy of 250 persons from 6:30 am until 5:15 pm on weekdays.

GROSS AREA (SQ.FT.): 81,065 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1970

STRUCTURE: Masonry

EXTERIOR WALLS: Stucco on CMU

ROOF: Pitched shingle roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Lay-in acoustical tile

WINDOWS: single and double pane clear glass in most of building and insulating glass in corridors.

COOLING EQUIP: Eight, 4-pipe, 5 HP, single zone central air handlers serving the general office area with three-way controlled CHW and HW coil, and face and bypass control. Fourteen, four-pipe fan coil units serving corridors, stairwells and first floor office areas on the east and west ends. All units are served by the central chiller in building 2265.

HEATING EQUIP: See cooling equipment above. All units are served by the central boilers in building 2265.

LIGHTING: Recessed fluorescent fixtures and scattered incandescent fixtures

DOMESTIC WATER HEATING: Gas fired hot water heaters in building to serve restrooms.

OTHER: Packaged computer room units with outdoor fluid cooler serve the computer room in building. Some rooms in basement served by window units.

REMARKS: Poor temperature control. Extremely hot inside during field visit in mid March. Some inside areas were above 100 degrees F. All HVAC systems appeared to be in good condition with the exception of the temperature controls.

## BUILDING DESCRIPTION

NAME: Buildings 2264, 2266

USE: Mainly barracks for single enlisted personnel, with administrative offices and classrooms. Also houses the Academy Museum and band area. Maximum occupancy of 255 persons per building on a continuous basis.

GROSS AREA (SQ.FT.): 98,190 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1970

STRUCTURE: Masonry

EXTERIOR WALLS: Plaster on stone

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Lay-in acoustical tile

WINDOWS: Single pane clear glass

COOLING EQUIP: Ten, 4-pipe multi-zone ( three to six zones) air handlers with three-way controlled CHW and HW coils. Temperature controller modulates CHW and HW valves to maintain leaving coil temperature setpoint while space temperature controls zone dampers. AHU's have economizer control but it has been de-activated. All units are served by the central chiller in building 2265.

HEATING EQUIP: See cooling equipment above. All units are served by the central boilers in building 2265.

LIGHTING: Recessed fluorescent fixtures with incandescent fixtures scattered throughout building.

DOMESTIC WATER HEATING: Gas fired hot water heaters in building to serve restrooms.

REMARKS: Poor temperature control. Extremely hot inside during field visit in mid March. All HVAC systems appeared to be in poor condition, especially the temperature controls.

## BUILDING DESCRIPTION

NAME: Building 2265

USE: Mainly barracks for single enlisted personnel, with administrative offices and classrooms. Also houses the mess hall and central boiler and chiller plants. Maximum occupancy of 600 persons at meal time, with approximately 200 persons on a continuous basis.

GROSS AREA (SQ.FT.): 105,564 STORIES: 3 DATE OF SURVEY: 3/13 to 3/17/95

DATE OF CONSTRUCTION: 1970

STRUCTURE: Masonry

EXTERIOR WALLS: Plaster on stone wall

ROOF: Pitched roof with shingles

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Concrete and tile

CEILINGS: Acoustical tile and gypsum wallboard

WINDOWS: single pane clear glass

COOLING EQUIP: Ten, four-pipe multi-zone (two to six zones) air handlers with three-way controlled DHW and HW coils. A temperature controller modulates the CHW and HW control valves to maintain leaving coil temperature setpoints while space thermostats modulate the zone dampers. All AHU's have economizer control, but it has been de-activated. All units are served by the central chiller in building.

HEATING EQUIP: See cooling equipment above. All units are served by the central boilers in a building to the South of this building. All three boilers have three-way valves on primary side which is used to mix supply and return HW to maintain supply HW temperature setpoint.

LIGHTING: Recessed fluorescent fixtures with incandescent scattered in building.

DOMESTIC WATER HEATING: Large gas fired boiler located in basement for domestic hot water heating in the building.

OTHER: Central chiller plant equipment in building and central boiler plant equipment in building behind. See HVAC Equipment Lists for descriptions. Steam boilers in basement serve kitchen equipment.

REMARKS: Poor temperature control. Extremely hot inside during field visit in mid March. All HVAC systems appeared to be in poor condition, especially the temperature controls. Boiler (heating water) plant appears in good condition, while chiller plant is aged.

## BUILDING DESCRIPTION

NAME: Building 2270

USE: Post Theater. Occupied on an average of once a month for a period of 4 hours. Maximum occupancy is 950 people.

GROSS AREA (SQ.FT.): 14,692 STORIES: 2 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1935

STRUCTURE: Masonry

EXTERIOR WALLS: Stucco

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Wood, tile, and concrete floor pad

CEILINGS: Plaster

WINDOWS: Single pane clear glass.

COOLING EQUIP: One (1) built-up, approximately 20 HP, DX, single zone AHU with face and bypass dampers supplies the building from a mechanical room on the second floor balcony. Single thermostat controls solenoid valve for cooling and HW valve. AHU is served by three R-12 compressors on the first floor (1- inoperable) and a closed circuit fluid cooler located in the penthouse.

HEATING EQUIP: Above air-side equipment has HW coil and is supplied by two (2) water tube HW boilers located on the first floor.

LIGHTING: Incandescent fixtures

DOMESTIC WATER HEATING: N/A.

OTHER: One (1) HW and one (1) CND pump in first floor mechanical room.

REMARKS: Supply air is distributed in this building through combination diffuser/light fixtures. Chilled water system operates year round.

## BUILDING DESCRIPTION

NAME: Building 2272

USE: H.Q. Command Staff, S1, S2, S3 - office space. Continuous occupancy of thirty-five (35) people between 7 A.M. and 5 P.M. on the weekdays.

GROSS AREA (SQ.FT.): 9,016 STORIES: 2 DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1930's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: 2'/2' lay-in acoustical tile

WINDOWS: Single pane clear glass.

COOLING EQUIP: 2-pipe wall mounted FCU's with wild coils served by ACR chiller that serves both 2272 and 2273. FCU's have no thermostatic control.

HEATING EQUIP: Above air-side equipment is supplied by water tube HW boiler located in the basement of bldg. 2273.

LIGHTING: 2-lamp suspended fluorescent fixtures

DOMESTIC WATER HEATING: 30 gallon DHW heater in basement not used.

OTHER: One (1) CHW/HW pump in basement of bldg. 2273.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Manual changeover valves are located in the basement of bldg. 2273.

## BUILDING DESCRIPTION

NAME: Building 2273

USE: H.Q. Command, S1, S2, S3 - office space. Continuous occupancy of three (3) people between 7 A.M. and 5 P.M. on the weekdays.

GROSS AREA (SQ.FT.): 2,854  STORIES: 1  DATE OF SURVEY: 10/26/95

DATE OF CONSTRUCTION: 1930's

STRUCTURE: Masonry

EXTERIOR WALLS: Brick

ROOF: Pitched French tile roof

FLOOR CONSTRUCTION: Pier and beam

FLOOR FINISH: Carpet

CEILINGS: Lay-in acoustical tile

WINDOWS: Single pane clear glass.

COOLING EQUIP: One (1) 3/4 HP, 2-pipe, single zone AHU with three-way controlled HW/CHW coil, and face and bypass dampers is served by ACR chiller that supplies both 2272 and 2273. Space temperature is maintained by modulating face and bypass dampers in conjunction with CHW or HW control valves. Unit is started and stopped by manual switch in occupied space.

HEATING EQUIP: Above air-side equipment is supplied by water tube HW boiler located in the basement of bldg. 2273.

LIGHTING: 2-lamp surface mounted fluorescent fixtures/troffers

DOMESTIC WATER HEATING: 30 gallon DHW heater in basement not used.

OTHER: One (1) CHW/HW pump in basement of bldg. 2273.

REMARKS: Domestic water for the building is not available due to a base wide policy that (generally) only buildings with requirements other that restrooms shall be provided with domestic hot water. Manual changeover valves are located in the basement of bldg. 2273. Supply air is distributed in this building through light fixture troffers.

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 2200
MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| HW Boiler | 1 | AJAX, # WGB-1050<br>831.7 MBH out | Bldg.2200 | 1995 | 1050 MBH |
| HW Pump | 2 | Weinman 2 HP<br>34 GPM, 64 ft. head | Bldg.2200 | 1995 | 1.49 KW |
| CHW Pump | 2 | Weinman 3 HP<br>72 GPM, 60 ft. head | Bldg.2200 | 1995 | 2.24 KW |
| Air Cooled Chiller | 1 | Trane, # CGADC604AEAOEGTR<br>460 V, 4 comp. 23.5 RLA ea.<br>cond. fans 6 ea. 1 HP ea., 60 tons | Bldg.2200 | 1995 | 80.16 KW |
| HW Boiler | 1 | Pennco, Model 1506<br>112.2 MBH out | Bldg.2244 | 1989 | 150 MBH |
| HW Circulator | 1 | TACO, Cartridge type, 1/16 hp | Bldg.2244 | 1989 | 0.05 KW |
| Air Cooled Condenser | 1 | York, HICA240A25A<br>comp. 1 ea. 230V, 80 RLA<br>3 cond. fans 4.3 FLA, 20 ton | Bldg.2244 | 1989 | 39.6 KW |
| Steam Boiler | 1 | American Boilers<br>No name plate<br>79.85 MBH design heating | Bldg.2247 | 1965 | 197.2 MBH |
| Water Cooled Chiller | 1 | Trane, R-12, Open drive, 208V, 20 HP<br>very old chiller<br>20 tons | Bldg.2247 | 1960 | 28.95 KW |
| Condenser Pump | 1 | ACE, model ALC-200<br>2 HP, capacity data not available | Bldg.2247 | 1975 | 1.49 KW |
| Cooling Tower | 1 | Marley, cross flow #4822<br>belt driven, 2 HP | Bldg.2247 | 1990 | 1.49 KW |
| Window Units | 2 | 1.5 tons<br>cooling only<br>9.0 EER | Bldg.2247 | 1990 | 4.24 KW |
| Chilled Water Pump | 1 | Paco, # 10-20953, 809 IMP<br>GPM & HD N/A<br>2 HP | Bldg.2250 | 1993 | 1.49 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 2200

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Chilled Water Pump | 2 | TEEL, 1.5 HP<br>GPM & HD N/A | Bldg.2248 | 1993 | 2.98 KW |
| HW Pump | 2 | TACO<br>1/8 HP<br>one pump for AHU, the other for FCUs | Bldg.2248 | 1993 | 0.19 KW |
| Air Cooled Chiller | 1 | Technical Systems # CA2CD75<br>460 V, 2 comp. 70 RLA ea.<br>cond. fans 6 ea. 2.3 FLA ea., 57.5 tons | Bldg.2248 & 2250 | 1990 | 79.5 KW |
| HW Boiler | 1 | Rite, Model 5430 56<br>#90<br>679 MBH out | Bldg.2248 & 2250 | 1990 | 900 MBH |
| HW Pump | 1 | Thrush<br>1/3 HP | Bldg.2250 | 1993 | 0.25 KW |
| Water Chiller | 1 | Chrysler #C2MN779-2<br>water cooled, centrifugal,<br>657 tons, R-11 | 2263, 2264, 2265, 2266 | 1973 | 598 KW |
| Chilled Water Pump | 1 | Paco<br>1526 gpm, 166 ft<br>100 HP | 2263, 2264, 2265, 2266 | 1973 | 74.60 KW |
| Condenser Water Pump | 1 | Paco<br>1971 gpm, 63 ft<br>50 HP | 2263, 2264, 2265, 2266 | 1973 | 37.30 KW |
| Cooling Tower | 1 | Built-up<br>crossflow, 2 cell<br>2-20HP fans | 2263, 2264, 2265, 2266 | 1973 | 29.84 KW |
| Hot Water Boiler | 3 | Ajax #WGB 4750<br>natural draft, watertube<br>2240 MBH output | 2263, 2264, 2265, 2266 | 1988 | 3,000 MBH |
| Heating Water Pump | 3 | Armstrong<br>207 gpm, 110 ft<br>15 HP | 2263, 2264, 2265, 2266 | 1988 | 11.19 KW |
| Boiler Circulation Pump | 3 | Armstrong<br>3/4 HP | Hot Water Boiler<br>2263, 2264, 2265, 2266 | 1988 | 0.56 KW |
| Condenser Pump | 1 | HP, capacity data not available<br>assume 5 HP | Bldg.2270 | 1970 | 3.73 KW |

HVAC EQUIPMENT LIST FOR: FORT SAM HOUSTON, AREA 2200

MARCH 1, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | YEAR INSTALLED | FULL LOAD |
|---|---|---|---|---|---|
| Cooling Tower | 1 | Water sprayed over the ref. coils<br>HP, capacity data not available<br>assume 3 HP | Bldg.2270 | 1970 | 2.24 KW |
| Ref. Compressor | 3 | Total original 100 ton capecity<br>*33.3 ton per compr. (2 operate)* | Bldg.2270 | 1970 | 68.4 KW |
| HW Boiler | 1 | AJAX # WG-750-S<br>SR # 87-39964 & # 87-39965<br>550 MBH out | Bldg.2270 | 1987 | 750 MBH |
| HW Pump | 2 | HP, capacity data not available<br>assume 3 HP | Bldg.2270 | 1970 | 2.24 KW |
| HW Boiler | 1 | AJAX # WG-750-S<br>SR # 87-39964 & # 87-39965<br>550 MBH out | Bldg.2270 | 1987 | 750 MBH |
| CHW / HW Pump | 1 | No name plate<br>120 GPM, 100 ft<br>5 HP | Bldg.2272 & 2273 | 1988 | 3.73 KW |
| Air Cooled Chiller | 1 | Technical systems # 30AOCD 40<br>2 comp. 57.7 RLA<br>4 ea. cond fans 1HP ea., 40 tons | Bldg.2272 & 2273 | 1988 | 52.87 KW |
| HW Boiler | 1 | AJAX # WG-525-S<br>388 MBH out | Bldg.2272 & 2273 | 1988 | 525 MBH |

| AREA: 100 | HARDWARE | | | | | | | | | | | | | | | | | | | | | | | | |
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| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | | | |
| ECO A: INSTALL EMS FOR HVAC EQUIPMENT<br>OCCUPANCY TIME: VARIES | | | | | | | | | | | | | | | | | | | | | | | | | |
| GRAPHIC DISPLAY ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | DIFFERENITAL PRESSURE | GAGE PRESSURE | | POSITION |
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| A/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHILLER | | | | | 19 | | | | | | | | | | | | | | | | | | | | |
| CHW PUMP | 23 | | | | | | | | | | | | | | 23 | | | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 19 | | | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 19 | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| COOLING TOWER | | | | | | | | | | | | | | | | | | | | | | | | | |
| TWR. FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CW PUMP | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
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| HW BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 21 | | | | | | | 21 | | | | | | | | | | | | | |
| HW PUMP | 25 | | | | | | | | | | | | | | 25 | | | | | | | | | | |
| HW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 21 | | | | | | | |
| HW RETURN HEADER | | | | | | | | | | | | | | | | | | 21 | | | | | | | |
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| STEAM BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER | | | | | 2 | | | | | | | 2 | | | | | | | | | | | | | |
| STEAM SUPPLY HEADER | | | | | | | | | | | | | | | | | | | | | | | 2 | | |
| STEAM RETURN HEADER | | | | | | | | | | | | | | | | | | | | | | | 2 | | |
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| AHU-SZ ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 10 | | | | | | | | | | | | | | 10 | | | | | | | | | | |
| CHW COIL VALVE | | | | | | 10 | | | | | | | | | | | | 10 | | | | | | | |
| HW COIL VALVE | | | | | | 10 | | | | | | | | | | | | 10 | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | | | | | | | | |
| FILTER | | | | | | | | | | 10 | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 10 | | | | | | | |
| OUTSIDE AIR | | | | | | | | | | | | | | | | | | | | | | | | | |
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| AHU-CLG ONLY SZ ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 1 | | | | | | | | | | | | 1 | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | | | | | | | | |
| FILTER | | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| OUTSIDE AIR | | | | | | | | | | | | | | | | | | | | | | | | | |

| ANALOG | | | | | | | SOFTWARE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | | | |
| AMPS | DIFFERENITAL PRESSURE | GAGE PRESSURE | | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | | | |
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| RUN TIME | KW | KWH | CFM | | | REMARKS |
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| AREA: 100 | | HARDWARE | | | | | | | | | | | | | | | | | | | | | |
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| ECO A: INSTALL EMS FOR HVAC EQUIPMENT | | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | |
| OCCUPANCY TIME: VARIES | | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALC | | | | |
| GRAPHIC DISPLAY | ● | | | | | | | | | | | | | | | | | | | | | | |
| POINT DESCRIPTION | | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESS. SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SENSING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | DIFFERENITAL PRESSURE |
| | | | | | | | | | | | | | | | | | | | | | | | |
| AHU (MZ) | ● | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | | 28 | | | | | | | | | | | | | | 28 | | | | | | | |
| COLD DECK TEMP. | | | | | | | 28 | | | | | | | | | | | | 28 | | | | |
| HOT DECK TEMP. | | | | | | | 28 | | | | | | | | | | | | 28 | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | | 28 | | | | |
| ZONE DAMPERS | | | | | | | | 56 | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | | 56 | | | | |
| FILTER | | | | | | | | | | | 28 | | | | | | | | | | | | |
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| FAN COIL UNIT | ● | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | | 20 | | | | |
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| PACKAGED AHU | ● | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | | 6 | | | | |
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| PACKAGED WINDOW UNIT | ● | | | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | | 56 | | | | |
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| OUTSIDE AIR | ● | | | | | | | | | | | | | | | | | | 1 | 1 | | | |
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TOTAL AO POINTS = 131

TOTAL DO POINTS = 133

TOTAL AI POINTS = 151

TOTAL DI POINTS = 339

GRAND TOTAL POINTS = 754

SOFTWARE

| ANALOG | | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| VOLTS | AMPS | DIFFERENITAL PRESSURE | GAGE PRESSURE | | POSITION | FLOW | O2 AND CO ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLING | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW O.A. RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | |
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| RUN TIME | KW | KWH | CFM | | | REMARKS |
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| X | | | | | | all valves, dampers, thermostats, and |
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